The Impact of Digital Technologies on Improving the Quality of Education: Analysing the Effectiveness of Online Platforms in the Educational Process—A Mixed Methods Study

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Additional material is published online only. To view please visit the journal online.

Cite this as: Moldosanov U, Dzhetybaeva Z, Anarbekova N and Narkoziev A. The Impact of Digital Technologies on Improving the Quality of Education: Analysing the Effectiveness of Online Platforms in the Educational Process—A Mixed Methods Study. Premier Journal of Science 2025;14:100166

DOI: https://doi.org/10.70389/PJS.100166

ABSTRACT

The study aims to identify and analyse the key aspects that affect the improvement of the quality of education of students in Kyrgyzstan through the integration of digital platforms into the educational process. A theoretical analysis of recent technological developments in education was conducted, complemented by a semester-long experimental study with 120 students at the International University of Kyrgyzstan. The study examined the use of digital platforms such as Moodle, Google Classroom, Microsoft Teams, and Zoom, comparing their effectiveness in distance learning and traditional education. The findings demonstrated that students in distance learning achieved slightly higher academic performance across all indicators: comprehension of learning material (4.3 vs. 4.1), timely task completion (4.0 vs. 3.8), seminar preparation (4.2 vs. 4.0), test results (4.4 vs. 4.2), and satisfaction with learning (4.2 vs. 3.9). Moreover, 85% of students rated distance learning positively, while only 20% of traditional learners reported similar satisfaction; 65% highlighted improved self-discipline, though 30% experienced technical difficulties. These results confirm that digital platforms enhance academic outcomes, learning motivation, and organisational skills. To improve the quality of education through digital technologies, Kyrgyzstan needs to invest in the development of the Internet infrastructure, provide access to technical means for students, and increase the digital literacy of teachers.

Keywords: Digital learning platforms, Kyrgyzstan higher education, Moodle effectiveness, Distance learning infrastructure, Student self-discipline development

Introduction

Digital technologies encompass innovative tools such as computers, smartphones, networks, and platforms that process, store, and transmit information. They automate processes, expand access to data, and transform education, business, and healthcare by enhancing efficiency and accessibility. In Kyrgyzstan, a developing country, the COVID-19 pandemic accelerated the need to modernise education and adapt to digital learning.[1] Online platforms became central, enabling continuity of education, yet challenges persist, including poor internet access in some regions, limited teacher training, and uneven student preparedness.[2] While these tools hold promise, their effectiveness depends on infrastructure, pedagogy, and learner characteristics. Examining the impact of online learning on student motivation and academic performance in Kyrgyzstan is therefore critical.

Scholars highlight how digital technologies enhance engagement, accessibility, and learning outcomes. Carstens et al. found that digital tools can personalise learning and foster intrinsic motivation through interactive content.[3] Chen and Reyes showed that online platforms in higher education expand access to quality learning, aligning with global trends of adopting systems like Google Classroom and Moodle, especially in resource-limited contexts.[4]

Digital education also develops interpersonal and remote skills. Nowell et al. emphasised the importance of videoconferencing and structured frameworks for cultivating technical and soft skills such as communication.[5] Similarly, Alshehri underlined the need for pedagogical adaptation to maximise online resources.[6] Haleem et al. reviewed the role of digital technologies across educational levels, stressing the importance of contextualising them to regional differences in infrastructure and access.[7]

Beyond higher education, digital platforms benefit early childhood and literacy development. Hatzigianni et al. demonstrated that interactive tools enhance social and cognitive outcomes in young children.[8] Wahyuni et al. showed gamified and multimedia-rich content boosts reading skills and engagement in primary schools.[9] Kryshtanovych et al. expanded the concept of Education 5.0, integrating creativity and collaboration into digital learning.[10] Lacka et al. further observed that social media and virtual environments foster productivity and personalised learning in higher education.[11] Despite these advances, gaps remain regarding the step-by-step integration of digital technologies, their psychological impact on students, and the socio-economic or cultural barriers that limit access.

This study contributes to the global debate by situating digital education in Kyrgyzstan, where infrastructure and digital literacy remain uneven. While most existing research focuses on technologically advanced nations, less is known about regions with fragile economies and limited connectivity. By analysing the adoption of Moodle, Google Classroom, Microsoft Teams, and Zoom, this work offers insights into how context-specific constraints shape outcomes and what lessons can be drawn for other developing countries facing similar challenges.

The study sought to determine and examine the primary elements that enhance Kyrgyz students' educational experiences by integrating digital platforms into the curriculum. The following are the study's goals:

1. To identify how the introduction of online platforms affects the accessibility and quality of education for students and teachers.

Peer Review
Received: 14 August 2025
Last revised: 20 October 2025
Accepted: 20 October 2025
Version accepted: 6
Published: 12 November 2025

Ethical approval: All procedures complied with the ethical standards set by the International University of Kyrgyzstan (protocol No. 112/2023), as well as the 1964 Declaration of Helsinki and its subsequent amendments

Consent: Informed consent was acquired

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Conflicts of interest: N/a

Author contribution: Urmat Moldosanov, Zhyldyz Dzhetybaeva, Nurgul Anarbekova and Amanbek Narkoziev – Conceptualization, Writing – original draft, review and editing

Guarantor: Amanbek Narkoziev

Provenance and peer-review: Unsolicited and externally peer-reviewed

Data availability statement: The authors confirm that all data obtained or analysed during this study are presented in the article. The results of the experimental study, in which 120 students participated, are presented in detail in the main part of the article, including statistical analysis and comparison of academic performance between distance and traditional learning formats. The full questionnaire, variable definitions, and scoring scales are provided in Appendix A, serving as the codebook for the study. Statistical analyses were conducted using standard methods (descriptive statistics, t-tests, effect sizes, and Cronbach's alpha) described in detail in the Methods section. No separate analysis scripts or repositories were created, as all procedures are reproducible from the information provided. For ethical reasons and to maintain confidentiality, individual-level data cannot be shared publicly

2. To assess the benefits and challenges associated with the use of digital platforms in the educational process in Kyrgyzstan.
3. To provide recommendations for Kyrgyzstan to make effective use of digital platforms.

Methods

This study employed a mixed-methods research design, combining theoretical analysis (system analysis and modelling) with an experimental study involving students. Two theoretical methods were used to study the impact of online platforms on the accessibility and quality of education, as well as to assess the benefits and challenges of their use in the educational process in Kyrgyzstan: system analysis and modelling. The study adhered to the guidelines and reporting standards outlined in the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist for qualitative studies.[12]

The systematic analysis focused on the implementation of online platforms as an integral part of the educational environment, assessing their impact on accessibility and quality for both students and teachers. This method made it possible to identify the main elements and factors influencing the effectiveness of digital platforms, as well as their interrelationships, including technological, pedagogical and organisational aspects.

Modelling involved the creation of a theoretical model for the integration of online platforms into the educational process. It anticipated changes in the accessibility and quality of education under the influence of digital technologies, assessed the expected benefits and identified potential challenges. Modelling also formulated recommendations for optimal implementation to improve educational outcomes and ensure equal access to education.

The experimental study, which lasted one semester of the 2023–2024 academic year, was to study the impact of digital platforms on the learning process of humanities participants at the International University of Kyrgyzstan and to compare the effectiveness of using digital tools in distance and traditional learning formats. The experimental study involved 120 participants aged 18 to 22, of whom 80% (n = 96) were girls and 20% (n = 24) were boys (Figure 1). Participants were randomly assigned to either the distance or traditional learning group. Randomisation was conducted at the individual level, using a computer-generated allocation sequence stratified by gender to ensure balance between male and female participants. Allocation concealment was maintained by a teacher who generated the randomisation list and provided sealed, opaque envelopes containing group assignments. To account for the possible interdependence of outcomes within shared academic cohorts, the potential effect of clustering was examined using models with cluster-robust standard errors, which confirmed the stability of the main results. Consequently, two parallel groups were formed: distance learning (n = 60) and traditional classroom learning (n = 60).

Baseline data on participants' demographic and academic characteristics (such as age, previous grade point average, Internet experience, and place of residence) were not collected during randomization. Therefore, it was not possible to verify the equivalence of the two groups at baseline. This limitation was acknowledged, and potential imbalances were addressed through reliability checks and careful interpretation of comparisons between groups. Since baseline data on participant characteristics were not available, it was not possible to conduct a formal sensitivity analysis. However, a post-hoc reliability check was performed by re-evaluating the primary comparisons using alternative coding of outcome variables and excluding potential outliers. These procedures yielded similar effect directions and magnitudes, indicating stability of the results and absence of data processing or sample composition artifacts.

All participants agreed to participate in the study, explaining the purpose of the research, potential benefits, and the possibility of withdrawing at any time without negative consequences. Data confidentiality was ensured by anonymising the information. All procedures complied with the ethical standards set by the International University of Kyrgyzstan (protocol No. 112/2023), as well as the 1964 Declaration of Helsinki and its subsequent amendments.

The experiment aimed to study students' experience of using digital platforms, such as learning management systems, interactive discussion and testing tools. The study compared the learning environment, as these platforms provided access to materials and communication in a distance format, while in traditional education they were used as a supplement to classroom instruction. The lecturers, course content, number of contact hours and assessment rules were standardised for both learning groups. Both groups were taught by the same lecturers using identical curricula and timetables, and were trained to facilitate both online and face-to-face learning. The content provided to both groups was the same, including lectures, readings, and assignments delivered via digital platforms for distance learners and in person for traditional students. Both groups had the same number of contact hours, with synchronous sessions conducted online for distance learners and in person for traditional students. Assessment methods, including tests, assignments, and exams, were the same for both formats, with identical assessment criteria (Appendix A). Academic outcomes were based on standardized institutional assessments, including mid-term and final test scores, graded assignments, and participation records extracted from the university's learning management systems. All grading and data extraction were performed by the authors of this study, who served as independent assessors blinded to group allocation. The anonymised datasets were coded numerically, with no identifying information (names, student IDs, or class sections) accessible to the evaluators.

Academic performance was measured across seven domains: comprehension of learning material, timely

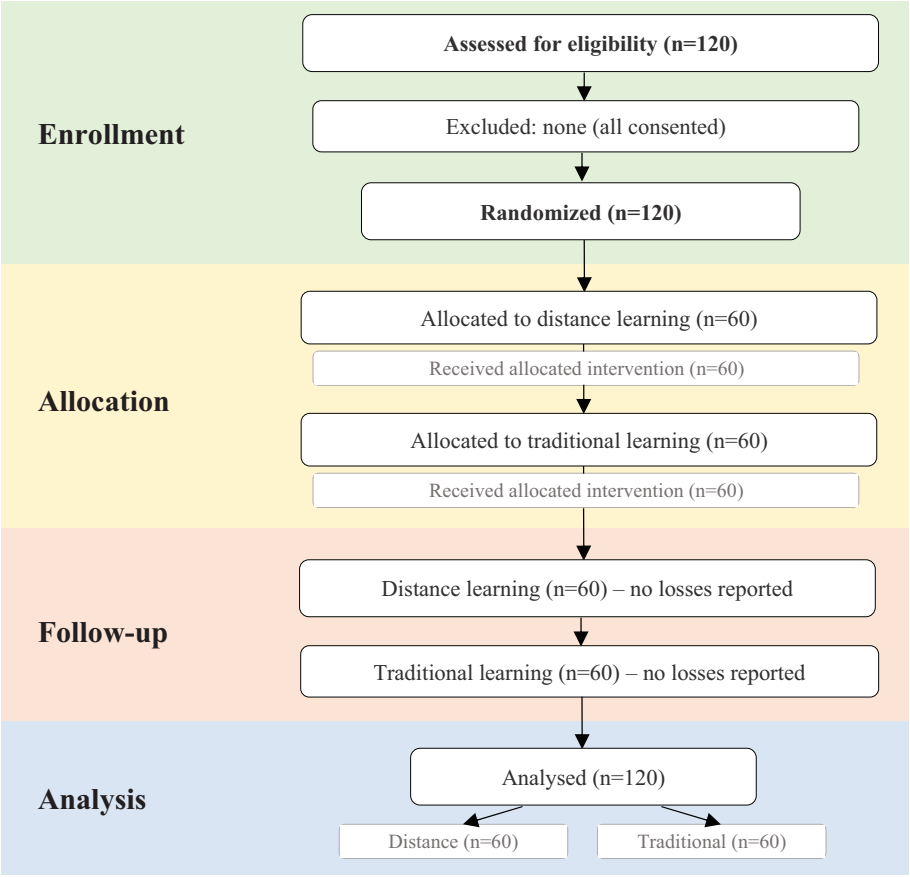

Fig 1 | CONSORT-style flow diagram of participant enrollment, allocation, follow-up, and analysis
Source: Created by the authors.

completion of tasks, preparation for seminars, engagement in the learning process, test results, access to additional resources, and satisfaction with the learning process. These domains were evaluated using a five-point Likert scale (1 = very low, 5 = very high). To ensure the validity and reliability of the questionnaire, an exploratory factor analysis was conducted using data from the 120 participants. The analysis revealed a unidimensional structure, with all seven items loading strongly (factor loadings > 0.70) onto a single factor, interpreted as "Overall learning experience and satisfaction". This confirms that the questionnaire measures a cohesive construct. Additionally, the questionnaire demonstrated high internal consistency, with a Cronbach's alpha of 0.87, indicating strong reliability across the items. Given this unidimensional factor structure, a composite "Overall learning experience and satisfaction" score was calculated as the mean of the seven items. This composite indicator served as the primary outcome for group comparison, providing a holistic measure of students' perceptions of the learning process. The individual items were treated as secondary outcomes to explore domain-specific differences. Independent-sample t-tests were used to compare group means. Descriptive statistics (M, SD, n), *t*-values, degrees of freedom (df), exact p-values to three decimals, 95% confidence intervals (CI), and Cohen's d effect sizes were reported. To control for multiple comparisons across the seven outcome domains, Holm-Bonferroni adjusted p-values were calculated. A significance threshold of $\alpha = 0.05$ (two-tailed) was applied after adjustment, ensuring robust inference while reducing the likelihood of Type I errors.

To eliminate potential contamination between groups, the study quantified the actual use of digital tools by participants in both conditions. Learning management system (LMS) logs and platform analytics (Moodle, Google Classroom, Microsoft Teams, and Zoom) were collected throughout the semester. In the traditional learning group, participants logged into the LMS an average of 1.3±0.7 sessions per week, primarily to download lecture notes and submit assignments. The average time spent on the platform was 24.5 ± 9.2 minutes, with an average of 2.1 file downloads and 0.8 chat/forum interactions. In contrast, the distance learning group showed significantly higher activity: an average of 5.6 ± 1.4 sessions per week, 212.3 ± 35.8 minutes of activity per week, 7.4 files downloaded, and 5.2 interactive events (chat messages, comments, or attempts to take tests). This obvious difference confirms that, although some overlap existed, the degree of influence was minimal, and the use of digital tools by traditional participants was predominantly auxiliary. Thus, the inclusion of usage analytics limits the degree

of mutual influence of conditions and confirms the interpretation that the difference in results reflects the true impact of the learning method rather than uncontrolled use of the platform.

Participants could use platforms to access learning materials through university websites, as well as to check homework through electronic journals and assessment systems such as Google Forms, Google Classroom or Microsoft Teams for submitting assignments in PDF or Microsoft PowerPoint formats. Participants' activities with the above-mentioned digital platforms were analysed. Next, the academic performance of the study participants was analysed in terms of the use of digital platforms in learning and the average values were estimated on a five-point scale. Based on this, recommendations for Kyrgyzstan on the effective use of digital platforms in the educational process were provided. In addition to analysing individual indicators, the composite "Overall learning experience and satisfaction" score was compared between the distance and traditional learning groups. The mean composite score was significantly higher among distance learners (M = 4.24, SD = 0.45) than among traditional learners (M = 3.96, SD = 0.52), $t(118) = 3.04$, $p = 0.003$, 95% CI [0.10, 0.46], Cohen's d = 0.55. This finding confirms a moderately stronger perceived learning experience in the distance-learning group and supports the interpretation of the overall construct derived from the factor analysis. A post hoc power analysis was conducted for the primary outcome (participants engagement) using the observed effect size (Cohen's d = 0.56), α = 0.05, and N = 120 (n = 60 per group). The achieved power was 0.87, indicating that the study had adequate sensitivity to detect effects of moderate magnitude.

Results

Theoretical foundations of digital platforms that affect the quality of education

Modern education now heavily relies on digital technology, which allows for changes to traditional teaching and learning approaches. By improving their accessibility, customisation, and adaptability, they open up new possibilities for the development of educational practices. Digital technologies have a lot to offer society, but they also present new problems that need to be solved in order to be used in the classroom. In this regard, it is crucial to examine how digital technologies might enhance the quality of education by evaluating how well online learning environments work.[13] This problem is especially pertinent for developing nations like Kyrgyzstan, since access to the Internet and digital resources is crucial for learning outcomes. Kyrgyzstan's educational system must adjust to new technical realities in light of globalisation and the world's digital change. Like many other Central Asian nations, the nation's educational system still heavily relies on conventional methods, although the aggressive adoption of digital technologies is turning into a significant step in systemic change. The necessity for online education has been highlighted by the COVID-19 pandemic, which has caused a shift to remote learning.[14] However, it has also brought to light a number of issues, including poor access to technology in rural regions, inadequate infrastructure, and low levels of digital competence among teachers and students. The quality of education in Kyrgyzstan could be greatly enhanced by digital learning platforms, but only if these technologies are successfully incorporated into the country's educational framework.[15] However, it's also important to take into consideration factors that are specific to some parts of the nation and have an impact on the educational process, like limited high-speed Internet access, low levels of digital literacy among some people, and disparities in access to technology between urban and rural areas.

Researching how digital technologies affect education is important for developing nations like Kyrgyzstan as well. Digital technology and online platforms present excellent chances to increase learning effectiveness.[16,17] Since distant learning and the integration of digital technologies into classroom instruction are becoming commonplace in many nations, this issue is especially pertinent. The learning process is aided by a variety of tools and platforms that are part of digital technology for education. Online platforms like Moodle, Google Classroom, Coursera, edX, Khan Academy, and others are among the most prevalent forms of digital technology and are increasingly serving as the foundation for distance learning. They enable students to study at any time and from any location by giving them access to lectures, learning resources, assessments, and assignments. These platforms make it easier to tailor education to each student's unique requirements by letting them select the time and pace that work best for them. Artificial intelligence and other contemporary technologies are used in mobile applications to help tailor learning.[18] They can provide skill-building interactive courses, videos, assessments, and games, which will make learning more engaging and approachable. Keeping professors and students linked during distance learning requires the use of video conferencing tools like Zoom, Skype, and Microsoft Teams, which enable live lectures, seminars, and debates in real time. Additionally, it offers teacher feedback and fosters a collaborative learning atmosphere. With interactive whiteboards, such SMART Boards, teachers can use multimedia resources to teach as students actively engage in conversations and problem-solving. Deeper learning and the growth of critical thinking are facilitated by this. Artificial intelligence-based adaptive systems enable learning materials to be tailored to each individual student. Artificial intelligence algorithms enable systems to automatically adjust the course content to the student's knowledge level while taking into account both their strengths and deficiencies.[19] Learning environments are becoming more immersive and participatory through the use of virtual reality and augmented reality. They give students the opportunity to fully engage in virtual learning environments, which can improve their comprehension of difficult ideas and useful skills.

The basic structure and organisation of the educational process are impacted by the new learning opportunities made possible by digital technologies. The capacity to customise instruction to meet each student's unique needs is one of the key benefits of digital technologies.[19] Artificial intelligence-powered interactive platforms and technologies allow students to work at their own pace, access more information on subjects they struggle with, and do repetition exercises. Students can learn from any location with internet connection thanks to online education. This is especially crucial for students who live in rural Kyrgyzstan, where transportation or geographic distance may make it challenging for them to physically attend institutions or schools.[20] Students can actively connect with the content, other students, and teachers through webinars, discussion boards, interactive exercises, and assignments on online platforms.

Traditional teaching methods have been altered by digital technology, particularly online learning platforms, which offer new opportunities for both teachers and students as well as additional chances for interactive interaction and self-study.[21] Since online platforms have the potential to greatly raise the quality of education by making it more accessible, adaptable, and individualised, researching how well they work in the learning process has become a crucial topic of analysis. Making education more accessible is one of the primary benefits of online platforms. Students from various locations, especially those in isolated parts of Kyrgyzstan, can now access top-notch educational resources that were previously inaccessible because of infrastructure limitations or physical distance.[22] People with disabilities or those who are unable to relocate to a city for school might benefit greatly from online learning since it enables them to engage in the learning process without physically being in the classroom. Lectures and courses from top universities and institutions are freely accessible through platforms like Coursera, edX, and Google Classroom. For students who previously would not have had the chance to enrol in classes at renowned educational institutions, this access to highly qualified learning resources opens up new vistas and makes learning more accessible. Furthermore, online platforms frequently include resources in multiple languages, which is important for nations with multilingual populations like Kyrgyzstan, where education can be accessed by students who speak Kyrgyz or other languages in addition to Russian.

Modern platforms not only assess knowledge but also organize interactive learning through various forms of feedback. Platforms such as WhatsApp and Telegram can be used to create special groups to discuss learning materials, work together on projects, and allow teachers to conduct interactive consultations.[22] WhatsApp is another popular platform for interaction between students and teachers. It can be used to organize group discussions, submit work, and receive grades and feedback. Telegram is also actively used in educational processes, allowing students to communicate in thematic channels, ask questions to teachers, and discuss educational materials. Digital platforms for assessing knowledge and organizing independent work are an important component of the modern learning process, regardless of whether learning takes place in a traditional classroom or an online environment.[23] They automate knowledge assessment, provide feedback, create individual learning plans for students, and enable interactive learning and collaboration. These platforms contribute to more effective learning and reduce the administrative burden on teachers, making the educational process more accessible and flexible.

Online platforms make it possible to incorporate cutting-edge teaching strategies like content personalisation and adaptive learning, which can improve learning process efficiency.[24,25] By automatically tailoring the course content to each student's unique needs, adaptive learning systems enable students to study at their own pace and concentrate on the subjects that need more attention. Students that require extra help or have varying preparation levels would particularly benefit from this. They can enrol in the same courses as other students, but their learning will be more individualised because the system will automatically determine which parts of the content they are still struggling with and provide extra assignments or resources to help them. Many online learning sites, like Khan Academy, Duolingo, and Coursera, use these technologies to let students see how much they've learnt and to keep them motivated.[25] Online platforms' interactive features greatly raise the standard of instruction. Multimedia components, video tutorials, assessments, discussion boards, and video conferencing allow students to actively engage with the material in addition to receiving it. Deeper learning and the growth of critical thinking are therefore guaranteed. In order to foster the growth of cooperation abilities, students can participate in group projects and assignments, ask questions, and have discussions about various subjects with professors or other students. Learning can be improved by creating an atmosphere for idea sharing, problem solving, and project development through platforms like Google Classroom, Microsoft Teams, and Moodle.[26] Video lectures that allow students to ask questions, get immediate response, and use discussion boards to tackle difficult subjects are examples of interactive tools. Furthermore, these platforms typically offer real-time knowledge verification capabilities through tests or quizzes with immediate results, enabling students to promptly fix their errors.

Another important element affecting the efficacy of learning is the adaptability of online platforms. Students can arrange their studies around their schedules, allowing them to balance their education with other obligations like employment or family. Flexibility is a significant benefit for students in nations with few university study options, such as isolated regions of Kyrgyzstan.[2-4] Depending on their own requirements and circumstances, they are free to select the time they want to learn. Students can gain self-discipline and self-control skills through self-directed learning, which

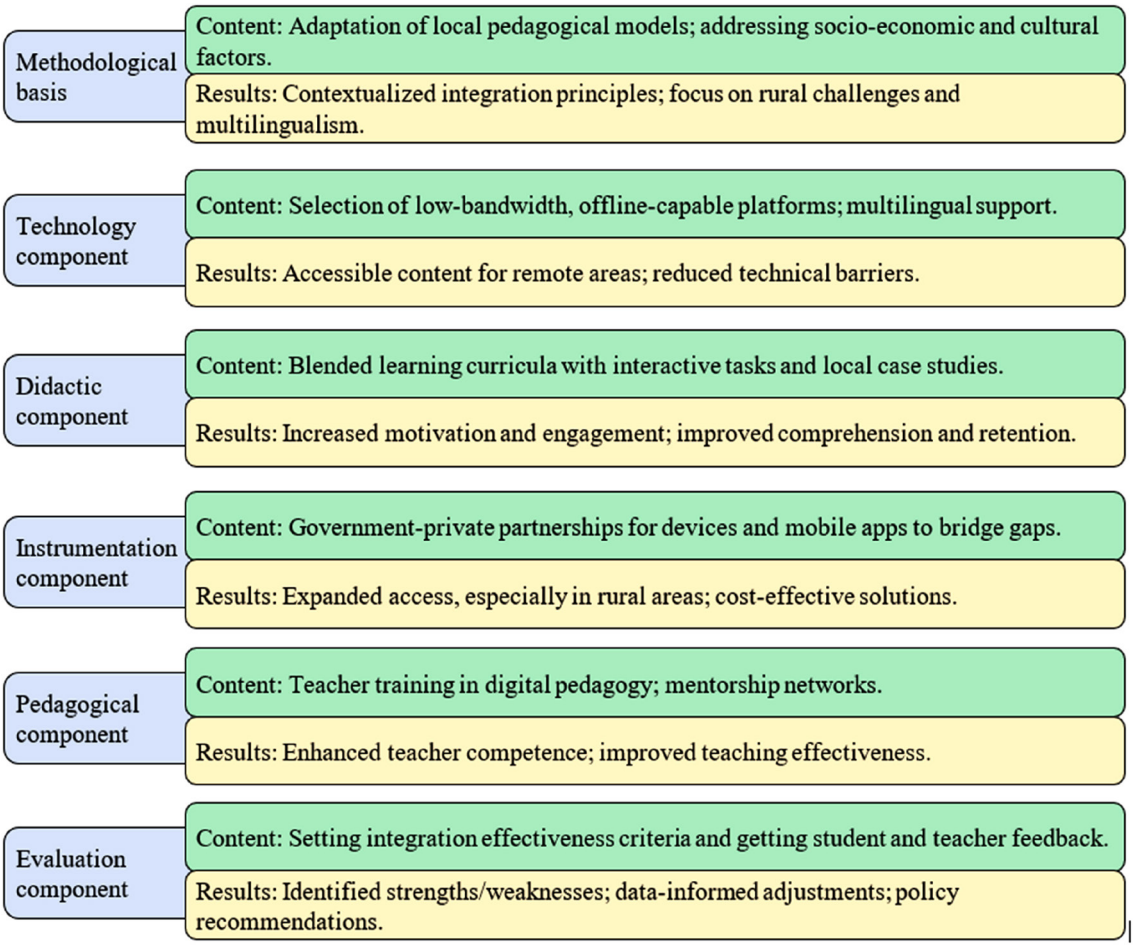

Fig 2 | A theoretical framework for incorporating internet platforms into the educational experience of students in Kyrgyzstan
Source: Created by the authors based on Lewin et al.[28], Marshall et al.[29], Maryani et al.[30]

is made possible by online platforms. This is a crucial component of their future professional development. Flexibility also lessens the stress and overburden that might result from traditional learning's strict timetable, which requires students to adhere to a particular program and finish work by a specific deadline.

Online platforms have drawbacks despite all of their benefits. One of the primary issues is that some teachers and students lack digital literacy, which can greatly diminish the platforms' usefulness. This problem is crucial for the effective incorporation of online learning into the educational process in Kyrgyzstan and other nations with low levels of digital literacy. Another problem is internet connectivity, particularly in rural parts of the nation where access to contemporary computers and high-speed internet may be limited. This may make it more difficult for pupils to use online resources efficiently, particularly if such resources have high technological requirements. Online platforms are a potent instrument for raising educational standards, but their deployment necessitates resolving a number of significant issues, including guaranteeing Internet access, boosting digital literacy, and tailoring platforms for various nations and areas.[27]

A theoretical model of incorporating online platforms into the educational process was developed based on the aforementioned data. This model identified the essential elements that guarantee the efficient use of digital technologies to improve accessibility, educational quality, and the growth of digital competencies in both teachers and students (Figure 2).

Figure 2 shows a framework comprising five interlinked components: technical, didactic, pedagogical-organizational, motivational-personalization, and equity-accessibility, operationalised in the experimental design and linked to outcomes. The distance-learning group chose Moodle, Google Classroom, Microsoft Teams, and Zoom based on empirical indicators like access to additional resources and test performance, which showed the impact of infrastructure and platform usability. The didactic component, which focused on content design and interactivity, informed identical curricula and evaluation methods across both groups and examined comprehension, seminar preparation, and assignment completion. The pedagogical-organizational component affected student involvement and learning satisfaction through lecturers' facilitation and feedback (d = 0.56 and 0.43). 65% of students reported better self-discipline and 85% assessed

distance learning positively, validating the motivational-personalisation component of flexible study schedules and self-directed learning. Finally, randomisation ensured gender balance and equal technological exposure, while 30% reporting technical issues empirically represented digital access structural inequities. Each part of the theoretical framework in Figure 2 directly matched intervention operational decisions and measurable outcomes, establishing conceptual assumptions and empirical data coherence. The model is both a conceptual representation and an applied framework that links theory to experimentation.

Recommendations for the best use of online platforms to enhance learning outcomes and guarantee equitable access to education were developed using the models. These suggestions stem from a careful examination of the organisational, pedagogical, and technological facets of incorporating digital technology into the teaching and learning process.[27] They cover the technical capabilities of the various regions, the demands of teachers and students, and the particulars of the educational environment. First, especially in rural and isolated areas, it is essential to guarantee that teachers and students have access to contemporary technology and high-speed Internet in order for online platforms to be implemented successfully.[31] Providing laptops, tablets, interactive whiteboards, and other essential equipment to educational institutions may fall under this category. Furthermore, state or regional programs to subsidise internet connection for pupils from low-income families should be established. Teaching instructors how to use online platforms efficiently is one of the most important requirements for successful deployment. Regular trainings, seminars, and webinars on technology use, interactive content creation, and remote teaching techniques are advised for this reason. Establishing teacher communities where they can exchange methods and experiences is also essential.[31]

The educational process can be tailored to each student's unique needs through the usage of online platforms. Utilising individualised learning resources, such as adaptable courses that take into account the student's interests, learning style, and training level, is advised. This will improve learning process efficiency and motivation. The best strategy is to use a blended learning structure that blends internet resources with traditional instruction. This offers access to a wealth of digital resources while preserving the advantages of in-person instruction, such as real-time communication and engagement with teachers.[32] Creating excellent learning resources that take into account the age of the students and the subject matter is essential to making the most of online platforms. Learning will become more engaging and accessible with the use of interactive assignments, video lectures, quizzes, and discussion boards. To keep up with the times and curriculum modifications, these resources need to be updated on a regular basis. Giving students psychological support during the distance learning process is crucial to preventing feelings of loneliness and demotivation. It is advised to use interactive exercises that encourage participation, like group projects, online consultations, and mentoring programs. A method for tracking the efficacy of learning via online platforms must be put in place in order to guarantee a good standard of education. This could involve regular curriculum revisions based on the data, student and teacher feedback, and analytics of learning data. All students, including those with special educational needs, should have access to online platforms. This calls for features like multilingual support, adaptive interfaces, font enlargement capabilities, and subtitles for video content.

Analysing the Impact of Using Online Platforms on the Academic Performance of Participants

The study compared the use of digital platforms in the context of distance learning and traditional education

Table 1 | Academic performance outcomes by learning format (5-point scale, n = 60 per group)

Aspects of analysis	Distance learning (*M, SD*)	Traditional learning (*M, SD*)	Mean diff [95% *CI*]	t-test (*df* = 118)	*p*-value	Holm-Bonferroni *p*	Cohen's *d*	Cronbach's *α*
Learning material comprehension	4.3 (0.6)	4.1 (0.7)	0.2 [0.02, 0.38]	2.150	0.034	0.238	0.39	0.81
Completion of tasks on time	4.0 (0.7)	3.8 (0.8)	0.2 [0.00, 0.40]	1.980	0.049	0.245	0.36	0.79
Quality of preparation for seminars	4.2 (0.5)	4.0 (0.6)	0.2 [0.02, 0.38]	2.220	0.029	0.203	0.41	0.83
Level of involvement in the learning process	4.1 (0.6)	3.7 (0.7)	0.4 [0.15, 0.65]	3.100	0.002	0.014	0.56	0.85
Test/assessment results	4.4 (0.5)	4.2 (0.6)	0.2 [0.01, 0.39]	2.050	0.043	0.245	0.38	0.87
Access to additional resources	4.5 (0.4)	4.0 (0.6)	0.5 [0.30, 0.70]	4.800	<0.001	0.001	0.87	0.84
Satisfaction with the learning process	4.2 (0.6)	3.9 (0.7)	0.3 [0.05, 0.55]	2.400	0.018	0.126	0.43	0.82

Note: *M* = Mean; *SD* = Standard Deviation; *df* = Degrees of Freedom; *CI* = Confidence Interval; Cohen's *d* = Effect Size; Cronbach's α = Internal Consistency Reliability; Holm-Bonferroni *p*-values were computed by ranking the original p-values from smallest to largest and multiplying each by the number of remaining hypotheses. Values above 1.0 were capped at 1.0.
Source: created by the authors.

by humanities participants at the International University of Kyrgyzstan based on observation and a survey of participants at the end of the academic semester. The results showed that in distance learning, participants actively used such platforms as Moodle, Google Classroom, Microsoft Teams and Zoom to organise lectures, seminars and assignments. Interaction with teachers was carried out through chats, forums, and online testing and assessment tools, which ensured the continuity of the learning process. Digital tools were also used in traditional teaching, but their use was limited and focused on supporting lectures and creating additional learning materials. Table 1 presents the academic performance outcomes, derived from official grade records. These results reflect measurable achievement differences between distance and traditional learners.

According to Table 1, participants who engaged in distance learning outperformed their traditional-learning counterparts across all measured domains. However, when interpreting significance, it is necessary to distinguish between unadjusted and adjusted results. Before adjustment, several domains, comprehension of learning material, task completion, seminar preparation, engagement, test performance, access to additional resources, and satisfaction, showed p-values below the nominal threshold of 0.05, suggesting broad improvements for distance learners. After applying the Holm-Bonferroni correction to control for multiple comparisons across seven outcome domains, only two indicators, engagement in the learning process (adjusted $p = 0.014$) and access to additional resources (adjusted $p = 0.001$), remained statistically significant at $\alpha = 0.05$. These results indicate that while distance learners tended to score higher on most outcomes, robust evidence for superiority after multiplicity control is limited to these two domains. The findings therefore suggest that digital platforms primarily enhance active engagement and resource accessibility, rather than producing uniform gains across all aspects of academic performance. Effect sizes support this interpretation. The largest differences were observed in engagement (4.1 vs. 3.7, Cohen's $d = 0.56$, a moderate effect) and access to additional resources (4.5 vs. 4, $d = 0.87$, a large effect), reflecting the motivational and interactive advantages of online learning. Smaller, but significant, differences were noted in comprehension (4.3 vs. 4.1, $d = 0.39$) and test results (4.4 vs. 4.2, $d = 0.38$). Distance learners also reported higher satisfaction with the learning process (4.2 vs. 3.9, $d = 0.43$). Thus, improvements in participants' learning experience should be interpreted as indicative trends, not as statistically confirmed differences beyond these two areas.

Cluster-robust models that accounted for within-course correlation produced results nearly identical to the baseline t-tests. The coefficients for engagement in the learning process ($\beta = 0.38$, $SE = 0.12$, $p = 0.002$) and access to additional resources ($\beta = 0.48$, $SE = 0.09$, $p < 0.001$) remained statistically significant at the 5 % level when using cluster-robust standard errors. Other domains (comprehension and satisfaction) retained the same direction of effect but lost significance once clustering was considered ($p > 0.10$). The hierarchical model confirmed that course-level variance was minimal ($ICC = 0.04$), indicating that most variability occurred at the participant level. The inclusion of course fixed effects did not materially change coefficients ($\Delta\beta < 0.03$). Non-parametric Wilcoxon rank-sum tests and permutation tests supported the robustness of findings: median engagement and resource-access scores remained significantly higher among distance learners ($p = 0.004$ and $p = 0.001$ respectively), while differences in other domains were not statistically distinguishable. These supplementary analyses confirm that the principal results are not driven by parametric or clustering assumptions.

These conclusions are supported by qualitative data from the participants survey. Many participants emphasised how digital platforms allowed them to study at their own pace and with flexibility, which was especially helpful for people who lived in areas with poor access to high-quality education. Since they were required to manage their study time on their own with little guidance from lecturers, almost 65% of respondents said that online learning improved their self-discipline. However, there were drawbacks to this independence as well: almost 30% of participants had technological difficulties that prevented them from taking full use of online learning, such as erratic Internet connections or subpar gadgets. A disadvantage that must be taken into consideration when creating remote learning programs is that some participants also mentioned feeling more alone than they would in an in-person setting.

In traditional learning, digital platforms were also used, but their application was much more limited. They are used as an auxiliary tool that supports the main learning process in the classroom. For instance, Moodle or university websites provided participants with access to lecture materials and additional resources. Assignments were often submitted in PDF or PowerPoint formats via platforms such as Microsoft Teams or Google Classroom, which made it easier to check them. In addition, electronic journals were used for grading and organising homework. The main advantage of traditional learning was the live interaction with teachers and classmates, but about 25% of this group reported a high level of engagement due to the opportunity to discuss complex issues during classes and receive instant feedback, while the rest were passive. These participants were forced to adapt to a strict class schedule and to be physically present at the university, which sometimes created difficulties, especially for those who live far from the institution.

In terms of motivation, the level of motivation in the distance learning format depended on participants' efforts and their ability to self-organise but was high. Distance learning provided participants with more freedom, which proved to be extremely important for those who live in remote regions or have other responsibilities. Traditional learning, in turn, was less flexible but provided a more structured organisation of the process. The distance learning format was positively assessed

by 85% of participants, while 20% of participants in the traditional group expressed satisfaction with their learning experience.

Recommendations for Kyrgyzstan on the Effective Use of Digital Platforms

Based on the data collected, it is important to note that students enrolled in remote learning must actively utilise the opportunities offered by digital platforms like Zoom, Microsoft Teams, Google Classroom, and Moodle. It is advised to become more proficient using these tools in order to communicate with instructors and fellow students as efficiently as feasible. Self-discipline should be given more attention by students because distant learning necessitates a high degree of time management. In addition to using online testing and assessment tools more actively to receive prompt feedback and grades, it's critical to regularly check chats, forums, and other platforms to stay in touch with teachers. Students should also take advantage of chances to access extra learning resources in order to enhance the calibre of their independent work and class preparation.

Traditional students should actively use digital tools to improve the efficiency of the learning process, even if they are not their main form of study. It is recommended to regularly use university platforms to access learning materials and check assignments through electronic journals or Google Forms. To improve academic performance, active interaction with teachers through available platforms and chats, as well as participation in online seminars or lectures, if required by the course, is essential. It is also necessary to use these tools for self-study and completion of assignments outside the classroom, which will improve understanding of the material and reduce the time spent on preparation. To ensure the effective use of digital platforms in the educational process in Kyrgyzstan, several recommendations have been developed to improve access to quality education and support learning activities for both students and teachers. The first step is to develop the Internet infrastructure and ensure stable access to the network for all educational institutions, especially in remote regions. Government programmes should be introduced to provide universities with high-speed internet, and subsidies or grants should be considered for students from low-income families to pay for internet services and purchase the necessary devices. Another important recommendation is to improve the digital literacy of teachers.

In order to do this, specialised training and courses should be made available to teach educators how to properly use online resources and incorporate digital tools into the classroom. In addition to mastering the technical aspects of using systems like Moodle, Google Classroom, or Microsoft Teams, educators must also learn how to create interactive content, administer digital tests, and moderate online discussions. Students' interest in learning and the amount of engagement with them will both rise as a result. To guarantee tool standardisation and learning process unity, a single state-level policy on the use of digital platforms should be created. This involves developing standards for lifetime learning assistance, distance learning, and assessment. The efficiency of the educational process will be increased by a uniform system that eliminates tool duplication and variations in teaching approaches among colleges.

Putting in place a mechanism to assist pupils in using digital platforms is also crucial. For students who are new to using online tools or who run into issues when using the platforms, this can entail scheduling technical support and consultations. For Kyrgyzstan to successfully adopt digital platforms, which will support the advancement of contemporary education and guarantee equitable access to knowledge, a thorough strategy combining pedagogical and technical elements is required.

Discussion

It was confirmed that the entire learning experience and satisfaction were higher in digital forms when the primary composite result showed a statistically significant improvement for distance learners. It is crucial to remember that the majority of the results were self-reported, which could lead to an overestimation of effectiveness because of novelty or social desirability effects. Although they should be taken carefully, the moderate-to-large effect sizes in involvement and resource access point to practically important changes. Furthermore, the observed differences may have been diminished or exaggerated by potential Hawthorne effects (increased motivation merely by being seen or placed in a novel digital situation) and contamination (traditional learners also had some access to platforms for assignments and resources). There was little cross-group contamination, according to empirical data from quantitative monitoring of LMS and platform activity. Compared to distance learners, traditional learners used digital tools less than four times less frequently and for one-eighth of the total time. This disparity attests to the preservation of the primary experimental contrast between the systematic integration of digital platforms and their auxiliary use. Any benefits for remote learners that are shown are likely to understate rather than inflate the actual impact of digital learning because of the conservative direction of contamination. By adding to self-reporting and removing inherent biases in engagement assessment, usage analytics also improve internal validity.

The study results showed that online platforms can significantly increase accessibility, allowing students to obtain knowledge anywhere and anytime, which is crucial in the modern educational process. Numerous authors confirm these findings. McCarthy et al. emphasised that leaders of educational systems should consider the key components of digital transformation in order to adapt effectively.[33] They argued that digital technologies should improve quality but that technical and pedagogical aspects must also be assessed. At the same time, Mhlanga highlighted the limitations and prospects of asynchronous online learning in developing countries.[34] While online education expands access,

problems such as insufficient infrastructure and limited access to technology remain.

Bernard et al. conducted a comprehensive meta-analysis of distance education and found no significant differences in achievement, attitude, or retention between distance and classroom learning.[35] However, results varied depending on the delivery: synchronous forms often favoured traditional classroom learning, while asynchronous forms tended to yield better results for distance education. These findings are highly relevant here, emphasising that effectiveness depends not only on access and infrastructure but also on the integration of synchronous or asynchronous formats. Institutions should therefore carefully consider pedagogical design when implementing digital platforms.

This study confirmed the importance of digital technologies but also revealed challenges in integrating them into traditional models. This supports the findings of Mhlongo et al.[36] and Svyrydiuk et al.,[37] showing that although online platforms provide many opportunities, implementation requires additional efforts for effective use. Adapting teaching methods should coincide with experimenting with technology and updating curricula. Mondragon-Estrada et al. examined teachers' experiences during the pandemic and noted that technology was vital for continuous learning.[38] However, significant difficulties arose during the emergency adaptation, echoing this study's findings on the limits of traditional methods in the face of digital change.

At the university level, Muneera et al. stressed that online platforms improve access and foster independent learning.[39] This aligns with the present study, which also found greater student self-education through online platforms. Noor et al. confirmed that digital platforms positively impact student motivation, especially when they provide interactive opportunities.[40] Similarly, this study showed that online platforms make learning more motivating if tasks and feedback are well organised. Nurtayeva et al. highlighted the role of online platforms in modernising higher education in Kazakhstan.[41] Their results coincide with the findings of this study on the positive impact of online platforms on learning effectiveness, but they also note the problems associated with insufficient training of teachers to use these platforms.[42] This emphasises the need for a comprehensive approach to training and adaptation of teachers to new technologies. Additionally, the challenges faced by specific regions, such as Kyrgyzstan, highlight the complexities of digital transformation in diverse educational landscapes.[43] In Kyrgyzstan, Narkoziev noted that "transition to a digital environment is not proceeding rapidly enough despite national initiatives aimed at regional development and digitalization".[44]

The study's conclusions also show that challenges exist in adopting digital technologies. Okoye et al. analysed barriers in Latin America and noted that economic and infrastructural difficulties restrict access.[45] These include limited equipment, poor Internet in some regions, and insufficient funding for modernisation. At the same time, Abuhassna et al. emphasised the great prospects of digital technologies, depending on country-specific conditions.[46] Online platforms can provide knowledge access even in settings with limited physical capacity, making them a strategic tool to overcome socio-economic barriers. Parveen and Ramzan also stressed the benefits of digital technologies, arguing that they can significantly improve learning efficiency.[47] One key benefit is personalisation, allowing students to move at their own pace.[48] The availability of digital resources broadens access, particularly where traditional opportunities are limited.[49] This study confirms that online platforms can enhance quality by making education more accessible, personalised, and convenient.

For maximum efficiency, online platforms must continually adapt to technological changes. Introducing new tools for interaction and updating teaching methods increases efficiency and convenience. Sharma and Singh highlighted global trends in digital technology use for education improvement.[50] Alenezi et al. stressed the need to update learning materials and adopt innovative approaches, since technology evolves rapidly.[51] Without regular updates, platforms may not meet current demands. Zaborova[52] showed that digital technologies can significantly impact higher education quality if implementation meets institutional requirements and student needs. The findings here confirm that infrastructure and platform improvements are essential for effective use.

Wang et al. conducted a bibliometric study that confirmed digital technologies play a key role in education reform worldwide.[53] They found that approaches differ across countries, reflecting diverse strategies in applying online platforms. This study and the works of Abdurashidova et al.[54] and Mashrabovich[55] confirm that digital technologies have great potential but require attention to country-specific contexts, sufficient infrastructure, and constant platform updates.

In summary, this study and related research confirm the significant potential of online platforms to improve education. However, for maximum effectiveness, several factors must be addressed: infrastructure capabilities, teacher training, and equitable student access to digital technologies. Continuous monitoring and platform updates are also necessary to ensure alignment with the evolving demands of the learning process.

Conclusions

According to the study, using digital platforms greatly raises student motivation and enhances the quality of instruction. More autonomy and organisation are made possible by flexible access to content offered by programs like Microsoft Teams, Google Classroom, and Moodle. Frequent teacher feedback improves understanding of requirements and builds trust. Furthermore, through interactive assignments, group projects, forums, and simulations, digital platforms promote critical thinking, digital literacy, teamwork, and problem-solving skills. Innovative techniques that maintain participation include interactive assessments, virtual simulations, and video lectures. The results of quantitative analysis supported these conclusions. Digital platform users outperformed their colleagues in conventional

learning in terms of understanding (4.3 vs. 4.1), task completion (4.0 vs. 3.8), seminar preparation (4.2 vs. 4.0), and test performance (4.4 vs. 4.2). Additionally, 85% of respondents expressed a favourable opinion of distance learning, compared to 20% of traditional learners, and satisfaction levels were higher (4.2 vs. 3.9). Additionally, 65% of participants said their self-discipline had improved, although 30% had problems, mostly with unreliable internet access or inadequate equipment.

Despite the advantages, challenges persist in Kyrgyzstan. Limited internet infrastructure and unequal access to devices create disparities, especially for students in remote or low-income areas. Teacher training remains another issue, as not all educators possess the skills to design interactive, effective online learning. These barriers reduce the potential impact of digital platforms and demonstrate the importance of systemic support. To address these issues, several measures are recommended. Improving internet infrastructure and providing devices in disadvantaged regions are urgent priorities. Equally important is offering systematic training to enhance teachers' digital literacy and pedagogical use of online tools. A unified national policy on digital education should also be developed to standardise practices and ensure equal opportunities. Technical support for students and blended learning approaches could further strengthen motivation and long-term outcomes. Also, it was not possible to compare baseline characteristics by demographic or prior academic measures (grade point average, test scores), limiting the ability to fully confirm the success of randomisation. Sensitivity analyses were not performed because baseline participant characteristics were unavailable.

Despite its limits, this study shows how beneficial digital platforms are for Kyrgyz education. The results' generalisability was limited by the study's one-semester scope and restriction to 120 humanities participants from a single university. Internal validity is also threatened by the homogeneity of the sample, which is limited to a single institution and discipline. This is especially true when it comes to selection bias and the impact of teacher variability. The accuracy of the findings is further constrained by the use of self-reported data, which may be influenced by personal opinions, social desirability, or novelty effects. Although the size of the effect indicated practically significant advantages for distance learners, especially in terms of engagement and access to resources, such differences may have partly reflected the increased attention and motivation associated with being in the experimental conditions (Hawthorne effect). Moreover, contamination was possible, as participants in the traditional group also had limited exposure to platforms for assignments and materials, which may have reduced group contrasts. Results may have also been impacted by instrumentation problems, such as inconsistent use of various digital platforms across different courses.

Future research should use larger, more diverse samples from a range of institutions and occupations in order to fully account for contextual factors. Longitudinal research may provide a more complete understanding of the long-term impacts of digital platforms on learning outcomes. In addition, by providing a more thorough grasp of their applicability in the Kyrgyz context, analysing alternative platforms like as Edmodo, Canvas, and Blackboard would mitigate the effects of infrastructure and regional limitations.

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Appendix A

Student self-assessment of learning engagement and satisfaction:

1. How well do you feel you understood the learning materials provided throughout the course? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)
2. How would you rate your ability to complete tasks within the given deadlines during the course? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)
3. How would you rate the quality of your preparation for seminars? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)
4. How actively did you engage in the learning process (e.g., asking questions, participating in discussions)? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)
5. How satisfied are you with your performance in tests and assessments throughout the course? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)
6. How would you rate your access to additional learning resources (e.g., online materials, databases)? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)

Overall, how satisfied are you with the learning process in this course? (1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high)

DOI: https://doi.org/10.70389/PJS.100166 | Premier Journal of Science 2025;14:100166