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Development of the Digital Environment in Ensuring the Quality of Training of Specialists

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Abstract The purpose of the study is to identify key aspects of the development of the digital educational environment and assess its impact on the quality of training of specialists. Special attention is paid to comparing digital platforms, analysing the content of training courses, reviewing the user experience through surveys, and observing the educational process. A mixed-methods approach was adopted, combining quantitative survey data with qualitative content and comparative analysis of digital platforms according to four criteria: convenience, integration, functionality, and interaction capabilities. Content analysis of training courses allows assessing the quality of materials, the presence of interactive elements, and the level of content adaptation to the digital environment. The survey, conducted on the basis of the Luhansk Taras Shevchenko National University, includes 250 respondents (180 students and 70 teachers), and monitoring the educational process helped assess the effectiveness of digital technologies in a real educational environment. The main results of the study show that the digital environment contributes to improving the availability of educational materials, personalising training, and automating knowledge assessment. Challenges related to technical difficulties, insufficient digital competence of teachers, and a decrease in the level of live communication are identified. A comparative analysis of the platforms demonstrates that Moodle is the most flexible, while Google Classroom and Microsoft Teams provide higher usability but have limited configurability. Content analysis shows that courses that contain interactive elements (video lectures, simulations, gamification) increase the effectiveness of material assimilation. The results of the study confirm that the digital educational environment has great potential to improve the quality of training of specialists. However, it is necessary to improve the interactive capabilities of the platforms, increase the digital literacy of teachers, and ensure a balance between online and offline interaction. The practical importance of the study is the development of recommendations for educational institutions on the effective implementation of digital technologies, improving the quality of content, and adapting the educational process to modern technological conditions. The results obtained can be used to improve educational policies, develop new digital learning methods, and enhance the effectiveness of educational process management.

Keywords Educational Technologies, Innovative Technologies, Distance Learning, Interactive Platforms, Competence Approach

AMS 2010 subject classifications 97U50, 68U35

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1. Introduction

The digital educational environment is an important factor in ensuring the quality of training of specialists. Technological changes affect the educational process, transforming approaches to learning and professional

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development. Educational institutions are implementing digital tools to create a dynamic and flexible space that meets the requirements of the labour market. The active use of digital technologies in the educational process contributes to increasing the availability of knowledge, interactivity, and personalisation of education. A new educational ecosystem is being formed, in which the digital environment is becoming an integral part of high-quality professional training.

The digital environment has played an important role in ensuring the quality of training of specialists, contributing to the introduction of innovative teaching methods and optimising the educational process. Kotun et al. [1] investigated the impact of digitalisation on higher teacher education in Ukraine during the crisis. They emphasised that the use of blended learning enabled the reduction of the negative impact of destructive factors and ensured the continuity of the educational process. The use of digital technologies in social and psychological work and regulatory support for this process was of great importance for protecting the rights of vulnerable groups of the population. Kurylo et al. [2] analysed the legislative aspects and capabilities of digital platforms in the provision of social services. They noted that digitalisation improved access to psychological support but also created challenges for personal data protection and cybersecurity. Critical thinking has become especially important in the context of growing information flows and digital threats. Kurylo et al. [3] evaluated the role of critical thinking in information security. The authors stressed that the ability to analyse information, recognise manipulations, and verify the accuracy of sources has become a necessary competence for specialists in the digital society.

Online education has expanded learning opportunities, providing for personalising the educational process and making it more accessible. Kvitka et al. [4] researched the development of online learning in Ukraine and around the world. They underlined those digital technologies have contributed to the improvement of teaching methods, but simultaneously pose challenges related to digital inequality and the need to train teachers to work in new conditions. International cooperation in the field of digital education has contributed to the introduction of advanced technologies and the exchange of experience. Otsbo et al. [5] reviewed the creation of a digital innovation hub within the framework of the scientific and educational partnership between Ukraine and Norway. They underscored that such initiatives helped integrate digital solutions into the educational process and strengthened the link between education and the labour market. The European experience of digital transformation of education has had a substantial impact on the modernisation of educational programmes in Ukraine. Strutynska [6] explored the process of digital transformation of education and the prospects for its development in a digital society. The researcher focused on the need to develop new approaches to learning that would consider the specific features of the digital space and the needs of students.

Digital technologies have also been used in the field of social work, especially in connection with the forced displacement of the population. Trubavina et al. [7] examined strategies to support displaced persons in the context of sustainable development. They stated that digital platforms provided communication between social services and communities hosting displaced persons, contributing to the integration and adaptation of these populations. The use of digital technologies in the professional training of specialists was instrumental in the formation of competencies. Yezhova [8] analysed the training of future specialists in the field of technology and design using digital solutions. It was noted that the implementation of the software allowed students to gain practical skills necessary to work in real-world production conditions. Innovative educational technologies have helped to improve the quality of training of specialists and ensure their compliance with the requirements of the labour market. Shalgimbekova et al. [9] investigated the main directions of improving the training of specialists using innovative training technologies. The study highlighted that interactive methods, virtual reality, and digital platforms allowed increasing the effectiveness of the educational process and motivating students. The digital age has changed not only educational methods but also educational standards themselves, making them more flexible and focused on practical skills. Christina Weber-Lewerenz [10] analysed the impact of digital transformation on education and training. According to the author, digitalisation required updating educational programmes, training teachers, and adapting students to a rapidly changing technological environment. Thus, the studies have shown that the digital environment plays a key role in shaping the competencies of specialists. The introduction of the latest technologies has contributed to improving the quality of education, expanding access to knowledge and adapting educational processes to the requirements of the digital economy. However, the digitalisation of education has also created new challenges related to data protection, digital inequality, and the need to develop effective teaching methods.

The study aims to analyse the development of the digital educational environment as a factor influencing the quality of specialist training. Its objectives include comparing leading digital platforms based on functionality, integration and usability, assessing course structure and interactivity through content analysis, and evaluating user satisfaction to identify key challenges and directions for improvement.

2. Materials and Methods

A mixed-methods research design was applied, integrating quantitative surveys with qualitative observation, SWOT analysis, and comparative/content analysis of digital educational platforms to ensure a comprehensive assessment of the digital learning environment.

A comparative analysis of digital educational platforms that are actively used in the educational process was conducted. The comparison was based on the following criteria: ease of use, integration with other services, availability of tools for assessing knowledge, opportunities for interaction between teachers and students, and availability of functionality. The analysis covered Moodle, Google Classroom, Microsoft Teams, and Zoom platforms with learning management system (LMS) integration. For a comprehensive assessment of the effectiveness of digital educational platforms, a SWOT analysis was applied to identify their strengths and weaknesses, opportunities and threats.

A content analysis of training courses hosted on the platforms under study was conducted. The structure of materials, their quality, and the presence of interactive elements (tests, video lectures, simulations, and gamified tasks) were analysed. To assess the level of use of digital technologies in the educational process, this study was designed as a case study and employed a survey conducted in questionnaire format on the Google Forms platform from January 1 to March 1, 2025. The case study focused on the Luhansk Taras Shevchenko National University and involved 250 respondents, namely 180 students and 70 teachers. The study involved 180 students (108 women and 72 men) aged 18-35 years and 70 teachers (42 women and 28 men) aged 28-45 years. The criteria for inclusion in the sample were participation in the educational process at a higher education institution and age from 18 to 45 years, while the exclusion criteria included lack of experience in using digital technologies in training or partial completion of the questionnaire.

Quantitative data were processed using descriptive statistics (frequencies, percentages, mean and standard deviation) and basic inferential statistics to extend interpretation beyond description. Specifically, (1) a one-sample t-test was used to test whether the average usability rating of the chosen platform (1-5 scale) differed from the neutral midpoint (3); (2) Pearson's chi-square tests were applied to evaluate differences in categorical distributions (e.g., distribution of platform use; group differences in perceptions where student/teacher cross-tabulations were available); and (3) for key proportions (e.g., "Yes" responses), 95% confidence intervals (Wilson method) were calculated to quantify sampling uncertainty. Statistical significance was evaluated at $p < 0.05$.

During the study, the provisions of the Code of Ethics by the American Sociological Association [11] were observed. The questionnaire contained 15 questions developed by the management of the higher education institution and aimed at evaluating the effectiveness of the digital environment and identifying the main problems (Appendix A). The questionnaire's internal consistency was tested using Cronbach's alpha reliability analysis. The alpha coefficient was determined for Likert-type items (e.g., 1-5 rating questions and other ordered response categories) after aligning the scoring direction so that higher scores consistently indicated more positive digital environment ratings. Reliability was assessed using standard levels ($\alpha \geq 0.70$ acceptable; $\alpha \geq 0.80$ good). Final dataset showed strong internal consistency (Cronbach's $\alpha = 0.82$), indicating that the quantitative questionnaire items assess a consistent construct linked to digital educational environment quality and usability.

The educational process was monitored at the Luhansk Taras Shevchenko National University, which actively used digital technologies. Students' interaction with digital platforms, the level of their involvement in the educational process, the speed of adaptation to new tools, and the effectiveness of digital knowledge assessment were analysed.

3. Results

3.1. Analysis of Digital Educational Platforms

The development of digital technologies substantially transforms the educational process, contributing to its flexibility, accessibility, and efficiency. The introduction of a digital environment can greatly expand the possibilities of teaching and learning through the use of interactive tools, automated assessment, and personalised approaches to mastering the material. This opens up new perspectives for education, allowing students to adapt their curricula to meet their needs, increase their engagement, and create more dynamic forms of learning. One of the key advantages of the digital educational environment is the ability to freely access educational materials, regardless of the geographical location of the student or teacher. This is especially important for distance and blended learning, which has gained popularity in recent years, 2023-2024. Due to educational platforms, students can get a high-quality education regardless of their place of residence, and teachers can use a wide range of tools to attract an audience.

Interactive technologies implemented in the digital learning environment contribute to more active participation of students in the educational process. The use of multimedia content, interactive tests, virtual laboratories, and gamification substantially improves the perception of information and makes learning more interesting and productive. Such tools allow creating training courses that meet the individual needs of each student, helping them learn the material at their own pace. Automated evaluation is another important component of the digital environment. Artificial intelligence and specialised algorithms help quickly and objectively assess students' knowledge. This both reduces the burden on teachers and provides a more transparent assessment process, minimising the subjective factor. However, the effectiveness of digital learning largely depends on the choice of the appropriate educational platform. It is the platform that is the basis of the educational process, providing convenient access to materials, supporting communication between participants in the educational process and opportunities for assessing knowledge. It is important that the platform meets the needs of both students and teachers, providing a simple and intuitive interface, integration with other services, and a wide range of educational tools.

Globally, the digital educational environment is a critical area of development that requires appropriate state support and legal regulation. The main aspects of this process, particularly state programmes, legislative initiatives, and the role of international standards, are considered further. Several strategic programmes aimed at developing digital competencies and integrating information technologies into the educational process are being implemented in Ukraine. In particular, the Cabinet of Ministers of Ukraine approved the concept for the development of digital competencies until 2025, which outlines challenges and defines ways to overcome them to improve digital literacy of the population [12]. In addition, the Ministry of Education and Science of Ukraine initiated a discussion on the concept of digital transformation of education and science, which provides for fundamental changes in the education system in accordance with global trends in digital development [13]. The European Council has approved recommendations aimed at building a high-quality digital education ecosystem to ensure successful digital education and training. These recommendations were developed by the European Commission to transform the education system according to the needs of the digital age and encourage creative and responsible use of technology [14]. International organisations such as UNESCO and the European Commission play an important role in setting standards and recommendations for digitalising education. Their initiatives contribute to the harmonisation of approaches to digital learning and ensure the exchange of best practices between countries. Thus, the combination of government programmes, legislative initiatives, and international standards creates a comprehensive approach to digitalisation of education, ensuring its quality and accessibility in the world.

A deeper look at adaptive educational technologies shows that AI-driven customisation is one of the best ways to boost student engagement and learning. Modern adaptive learning systems assess students' past performance, behaviour, and progress using machine-learning algorithms. The system modifies task difficulty, tempo, and content type based on these facts. A continually adjusted individual learning trajectory replaces a fixed material sequence. Duolingo-like services use reinforcement learning algorithms to identify knowledge gaps and automatically construct tailored training sequences to fill them, enhancing retention and student motivation [15]. STEM courses in higher education increasingly incorporate adaptive problem-solving modules to help students progress from basic to sophisticated tasks while obtaining automated formative feedback. This method decreases cognitive overload

and promotes mastery. Beyond content customisation, AI improves assessment quality. Intelligent tutoring systems can identify recurrent errors, provide targeted hints, and change scaffolding to improve conceptual understanding rather than rote memorisation. AI-supported dashboards let teachers identify at-risk students for early intervention. Continuous diagnostic evaluation, adaptive material sequencing, automated feedback mechanisms, and predictive analytics for student support are AI education best practices. However, instructor digital literacy, training dataset quality, and adaptive algorithm alignment with curricular goals determine the efficacy of such systems.

VR/AR expands digital education by offering learning experiences that traditional platforms cannot. Virtual reality lets students practise difficult medical, engineering, architectural, and design tasks without risk. VR-based training increases psychomotor skills, spatial reasoning, and procedural accuracy, making it useful for high-stakes professional education [16]. AR enhances physical learning settings by superimposing digital images on real items. In biology, chemistry, and technological sciences, dynamic 3D models can explain abstract processes like molecular interactions, mechanical movement, and anatomical structures, enabling context-aware learning. Best practices for effective implementation of VR/AR technologies emphasise several pedagogically grounded principles. First, task-specific immersion should be ensured, meaning that VR modules must simulate real procedures directly aligned with the intended learning outcomes rather than offering abstract or overly gamified environments. Second, guided exploration is essential, as immersive experiences become significantly more effective when accompanied by prompts, reflective questions, or instructor guidance that helps students navigate the virtual setting meaningfully. Another critical element is the use of interactive and manipulable 3D objects, which have been shown to improve conceptual understanding far more than passive observation. Finally, the effective use of immersive tools requires integration with assessment, whereby student performance in VR tasks is systematically monitored, recorded, and translated into progress indicators within the LMS to support both formative and summative evaluation.

Comparative studies show that immersive tools significantly increase engagement, attention, and satisfaction. However, their effectiveness depends heavily on the instructional design. Overly complex VR environments can distract from learning objectives, and hardware limitations may introduce accessibility barriers. When adaptive technologies and immersive tools are used together within digital platforms such as Moodle, Microsoft Teams, or integrated LMS-VR ecosystems, they create multi-layered learning environments that support differentiated instruction, experiential practice, and continuous feedback. In professional training programmes, this hybrid approach enhances readiness for real work conditions, offering a combination of theoretical, procedural, and reflective learning stages. Despite clear advantages, integration challenges remain. These include the need for teacher training, ensuring interoperability between VR tools and existing LMS systems, addressing cybersecurity concerns associated with AI analytics, and maintaining equitable access for students with limited technological resources. Addressing these limitations requires institutional strategies focused on technical support, pedagogical training, and gradual scaling of immersive and AI-adaptive modules into curricula.

Blockchain technologies are used in education to ensure the transparency and reliability of knowledge certification. The use of blockchain helps create immutable and secure records of students' academic achievements, which simplifies the process of recognising qualifications and prevents falsification of diplomas. This is especially true in the context of the globalisation of education, when it is necessary to quickly and reliably confirm the competencies of graduates at the international level [17]. The integration of these technological trends into the educational process contributes to improving the quality of training, making it more flexible and adaptive to the needs of society.

In the context of the digital educational environment, a number of platforms that allow distance and mixed learning have become widespread. Among the most popular solutions are Moodle, Google Classroom, Microsoft Teams, and Zoom with LMS integration. Each of these platforms has its own characteristics, advantages, and limitations [18]. Moodle is one of the most flexible platforms that allows adapting the educational process to the needs of an educational institution, due to its open-source code and wide customisation options. Integrated into the Google Environment, Google Classroom is easy to use and effectively manages learning tasks, although it has limited functionality compared to other platforms. Microsoft Teams combines video conferencing, collaboration, and course management features to make it convenient for interactive learning. Zoom with LMS integration is mainly used for video tutorials, but requires additional tools for full management of the educational process. A

comparative analysis was conducted according to the criteria presented in Table 1 to evaluate the capabilities of these platforms.

Table 1. Comparative analysis of educational platforms

Criterion	Moodle	Google Classroom	Microsoft Teams	Zoom with LMS integration
Ease of use	Requires configuration, more complex interface	Intuitive, minimalistic	Integration with Office 365 requires adaptation	Focused on video tutorials, easy to use
Integration with other services	High (plugins, APIs)	Google Drive, Docs, Meet	Office 365, OneDrive, Outlook	Integrates with the LMS, but is limited on its own
Assessment of knowledge	Flexible test system, gradebook	Easy task evaluation, comments	Automatic grading, test support	No grading, requires additional solutions
Interaction between teachers and students	Forum, chats, message system	Chats, comments, integration with Meet	Built-in video meetings, chats, and group discussions	Video communication, integration with LMS
Availability of functionality	A large set of functions, expandable	Limited content management capabilities	Wide functionality, but requires a license	Minimal set of functions, requires additional services

Source: compiled by the authors based on O. M. Haitan [18].

Based on the analysis, it was shown that Moodle is the most versatile solution, suitable for complex training courses with the possibility of full control over the educational process. Google Classroom is convenient for basic learning, but it has a limited set of features. Microsoft Teams provides efficient communication and integration with enterprise services, and Zoom with LMS integration is the optimal solution for video tutorials, but it does not offer complete management of the learning process. The results obtained display the advantages and disadvantages of each platform. Therefore, for a comprehensive assessment of the effectiveness of digital educational platforms, a SWOT analysis was conducted, the results of which are presented in Table 2.

Table 2. SWOT analysis of digital educational platforms

Strengths	Weaknesses
Flexible access to training materials anytime, anywhere	Technical limitations (the need for a stable internet connection and appropriate equipment)
Automation of knowledge assessment (tests, electronic journals)	Lack of a universal platform that fully meets all educational needs
Ability to use multimedia content (video lectures, interactive simulations) and communication support (chats, forums, video conferences)	Limited functionality in some systems for creating interactive content
Effective organisation of the educational process through course management systems	Reducing the level of direct interaction between students and teachers
Opportunities	**Threats**
Integration of artificial intelligence to personalise learning	Cybersecurity and risks of personal data leakage
Expanding gamification to increase student motivation	High level of dependence on technologies and possible server failures
Improving the accessibility of education for people with disabilities	Lack of digital skills among some teachers and students
Further development of cloud technologies for storing and processing educational materials	Impact of digital education on the level of social interaction and communication skills of students

Source: compiled by the authors.

Based on the results of the analysis, it can be concluded that digital educational platforms have great potential for improving the educational process, but their effectiveness depends on eliminating technical and pedagogical restrictions. The use of artificial intelligence, improving interactive capabilities and the level of digital literacy of teachers and students will help expand the capabilities of the digital environment in education.

3.2. Research of the Content of the Digital Learning Environment

A content analysis was conducted to better understand and evaluate the effectiveness of training courses posted on the studied digital platforms, which allowed identifying the features of the structure of materials, their quality, and the presence of interactive elements that affect the effectiveness of knowledge acquisition; the results are presented in Table 3.

Table 3. Content analysis results of educational platforms

Criterion	Moodle	Google Classroom	Microsoft Teams	Zoom with LMS integration
Pedagogical strategy	Outcome-based, active learning, formative assessment, problem-based tasks	Predominantly content delivery, limited active learning	Collaborative learning, synchronous interaction	Lecture-based, teacher-centred
Feedback mechanisms	Automated and instructor feedback integrated	Mostly delayed or written feedback	Real-time verbal feedback	Minimal or informal
Student-centred learning	High (self-paced modules, adaptive tasks)	Low–medium	Medium	Low
Industry alignment	Case studies, simulations, project-based tasks, digital tools	Mostly theoretical assignments	Group projects, presentations	Rarely present
Development of transferable skills	Digital, analytical, teamwork, self-regulation	Limited	Communication, teamwork	Limited
Professional orientation	Explicit and systematic	Fragmentary	Moderate	Weak

Source: compiled by the authors based on P. Kvak [19].

Pedagogically, the analysis showed significant platform-specific instructional strategies. The majority of Moodle courses used outcome-based and modular instructional design, with learning objectives explicitly linked to assessment activities. These courses included interactive quizzes, formative exams with feedback, discussion forums, and scenario-based assignments to promote active learning and knowledge reinforcement. Constructivist methods encourage analysis, problem-solving, and reflection. In contrast, Google Classroom courses focused on content-transmission mechanisms including lecture materials and assignment collection. Organisational clarity is supported by this paradigm, however formative feedback, peer interaction, and iterative learning cycles are unclear. Asynchronous, teacher-centered pedagogical interaction limited collaborative learning and active student engagement in these courses.

Microsoft Teams-based courses supported collaborative and communication-oriented instructional practices, especially synchronous discussions, channel group work, and real-time feedback during online sessions. Since advanced instructional design features were not often systematically implemented into course structures, teachers' digital teaching competencies were crucial to these courses' pedagogical efficacy. Zoom with LMS integration courses had the least instructional diversity. The majority of instruction was synchronous lectures with little student-centredness. Without integrated assessment and feedback mechanisms, such courses replicated lecture-based methods rather than using digital environments for pedagogy.

Only a few courses were professional in harmony with industry standards, according to content analysis. Moodle-based courses typically included applied case studies, project work, professional task simulations, and industry-relevant digital technologies. These features promote transferable abilities like digital literacy, critical thinking, teamwork, and self-regulation, which employers increasingly value. However, many Google Classroom and Zoom courses barely integrated real-world professional situations, with assessment assignments limited to theoretical

knowledge reproduction. This diminishes the link between academic training and labor-market needs, especially in practical and adaptive problem-solving domains. Microsoft Teams courses that incorporated collaborative projects and workplace communication simulations met industry standards at the intermediate level. However, courses did not regularly reference professional standards, industry frameworks, or employer requirements.

3.3. Assessment of the Impact of the Digital Environment on the Effectiveness of the Educational Process

A survey was conducted among students and teachers of higher educational institutions to determine the level of use of digital platforms, their effectiveness, and the main platforms. Table 4 summarises respondents' answers to key questions in the questionnaire.

Table 4. Results of a survey on the use of digital technologies in the educational process

Questions	Response results
1. What educational platform do you use most often?	Moodle – 40%, Google Classroom – 30%, Microsoft Teams – 20%, Zoom with LMS integration – 10%
2. How convenient is it to use your chosen learning/teaching platform? (scale 1-5)	Mean score – 4.2 (40% – 5 points, 35% – 4 points, 20% – 3 points, 5% – 2 points)
3. Does the digital environment improve the quality of education platforms? (scale 1-5)	Yes – 55%, Partially – 35%, No – 10%
4. Are there enough digital training materials?	Yes – 60%, No – 40%
5. What are the most effective formats of training materials?	Video lectures – 50%, interactive tests – 25%, text files – 15%, simulations – 10%
6. How often do you use online tests or automated assessment?	Regularly – 45%, Sometimes – 40%, Rarely – 15%
7. Do you encounter technical problems during the education process? If so, which ones?	Yes – 85% (of these: low internet speed – 40%, problems with access to platforms – 30%)
8. Does digital learning reduce the level of live interaction?	Yes – 65%, No – 15%, Partially – 20%
9. How satisfied are you with the level of support from teachers or technical support?	High level – 35%, Medium – 45%, Low – 20%
10. Do you have enough skills to use digital technologies effectively?	Yes – 75%, No – 25%
11. How does the digital environment affect your motivation to learn?	Positively – 50%, Does not affect – 35%, Negatively – 15%
12. How do you assess the level of training of teachers to work in a digital environment?	High – 30%, Medium – 50%, Low – 20%
13. Does your educational institution support improving the digital competence of students and teachers?	Yes – 65%, No – 35%
14. What aspects of the digital environment need to be improved?	Most frequently mentioned: platform stability, integration of new tools, technical support
15. What are your suggestions for improving digital learning?	Most frequently mentioned: introduction of new teaching methods, expansion of interactive opportunities, improvement of digital literacy

Source: compiled by the authors.

A chi-square test comparing students and teachers on the item "Does the digital environment improve the quality of education?" (Yes/Partially/No) showed no statistically significant difference between groups ($\chi^2(2) = 0.69$, $p = 0.707$), suggesting broadly similar perceptions across students and teachers in this sample. The survey results demonstrate that digital educational platforms are actively used in the educational process. The most common platform is Moodle, and the main format of educational materials is video lectures. (Moodle: 100/250; Google Classroom: 75/250; Microsoft Teams: 50/250; Zoom+LMS: 25/250). The distribution of platform preference differed significantly from an equal distribution across platforms ($\chi^2(3) = 50.00$, $p < 0.001$), indicating a clear dominance of Moodle in the studied institution. The majority of respondents (55%) believe that the digital environment has a positive impact on the quality of education, but there are certain problems, such as reduced levels

of live communication, technical difficulties, and incomplete interactivity of training courses. (Yes: 138/250). The estimated proportion was $p = 0.552$ with a 95% CI [0.490; 0.612], indicating that a majority view is supported even when accounting for sampling uncertainty. An association test between self-reported digital skills (Yes/No) and satisfaction with support (High/Medium/Low) indicated a statistically significant relationship ($\chi^2(2) = 28.51$, $p < 0.001$): respondents reporting sufficient skills more often reported high satisfaction, whereas respondents reporting insufficient skills were overrepresented in the low-satisfaction category. Results of monitoring the use of digital technologies in the educational process as part of the study.

The open-ended responses to questions 14 and 15 (which ask, "What aspects of the digital environment need to be improved?" and "What are your suggestions for improving digital learning?") were thematically analysed using inductive coding and then grouped into higher-order categories in order to further interpret the survey results. With additional supporting themes pertaining to platform stability and course design quality, the research validated two prominent clusters that account for the difficulties: decreased pedagogical interaction and unequal instructor digital competency. Specifically, "reduced live communication" was defined as fewer synchronous sessions, less immediate feedback, fewer opportunities for peer collaboration, and a propensity for one-way content distribution (tasks and materials without prolonged discourse). Practical repercussions of these interaction deficiencies in the learning process included decreased motivation over time in entirely distance forms, more formal assignment completion, weakened group cohesion, and a higher frequency of misunderstandings as a result of delayed clarification. However, responses distinguished between the advanced digital-pedagogical skills necessary for successful online teaching (designing interactive assessments, facilitating online discussions, creating interactive content, and using platform tools to support engagement and timely feedback) and the basic operational skills (navigation, uploading/structuring materials, assignment workflows, gradebook use) that were considered to be part of the "insufficient digital competence of teachers". As a result, the topic findings show that enhancing quality necessitates both technical platform optimisation and focused actions to re-establish interaction routines and enhance teachers' pedagogical and operational competencies.

The educational process was monitored in educational institutions that actively use digital technologies. Observation was conducted during one academic semester in groups of students studying in mixed and distance forms; the results are presented in Table 5. To eliminate subjectivity and ensure replicability, each observation criterion was operationally defined using quantifiable indicators. Active interaction was measured by the average number of actions per student per week (logins, viewing materials, forum posts, assignment checks), where high activity corresponded to ≥ 15 actions, medium to 7–14, and low to ≤ 6. The level of involvement was assessed through assignment submission rates and attendance at synchronous sessions: high involvement required at least 85% submissions and 80% attendance, medium 60–84% and 50–79%, and low below these thresholds. Speed of adaptation was determined by the time needed to correctly perform tasks on digital platforms and the number of teacher interventions: high adaptation involved full task accuracy within one week and no more than two prompts, medium required 1–3 weeks and 3–5 prompts, while low meant more than three weeks and over five prompts. The effectiveness of knowledge assessment was evaluated by the correlation between automated test scores and instructor assessments, with optimal effectiveness reflected in correlations ≥ 0.75 and discrepancies $\leq 10\%$, medium in correlations of 0.50–0.74, and low in values below 0.50. Based on these indicators, the observation results were recalculated and the categories "High", "Medium" and "Low" in Table 5 were assigned according to these defined thresholds.

Source: compiled by the authors.

The empirical findings also indicate that the effectiveness of digital learning is constrained by infrastructural and socioeconomic barriers to access, which explain part of the reduced engagement observed in fully distance formats. The survey shows that 85% of respondents experienced technical problems, most often low internet speed (40%) and difficulties accessing platforms (30%), confirming that stable connectivity and reliable platform performance remain critical prerequisites for participation. These infrastructural limitations disproportionately affect students living in remote areas or unstable conditions and restrict access to bandwidth-intensive learning formats (video conferencing, simulations, interactive modules). Socioeconomic factors further intensify the access gap: limited household resources may reduce the availability of personal devices, licensed software, and adequate learning

Table 5. Main results of the observation.

Criterion	Blended learning (online and offline)	Fully distance learning
Active interaction with platforms	High, students actively use educational materials, forums	Medium, activity decreases with long-term distance learning
Level of involvement in the educational process	High, due to the possibility of direct contact with the teacher	Moderate, some students perform tasks formally
Speed of adaptation to new tools	High, due to the support of teachers and classmates	Medium, adaptation depends on the level of digital literacy
Effectiveness of knowledge assessment	Optimal, the combination of digital testing and traditional evaluation gives the best results	Lower, test scores do not always fully reflect the level of knowledge

spaces, while lower digital competence (reported by 25% of respondents) can compound exclusion through reduced ability to troubleshoot, participate in interactive tasks, and maintain consistent learning routines. Consequently, unequal access conditions operate as a structural determinant of learning involvement and contribute to the decline in activity during long-term fully distance learning identified in the observation.

To mitigate digital inequality, institutions should implement a targeted set of measures. At the infrastructural level, these include strengthening platform stability, expanding technical support, and introducing device-lending schemes and subsidised connectivity for disadvantaged groups. At the pedagogical level, courses should be designed with low-bandwidth alternatives (asynchronous options, downloadable materials, reduced dependence on continuous video streaming), while maintaining interaction through structured discussion tasks and timely feedback. At the institutional level, the blended model shown to be most effective in this study should be used strategically to compensate for unequal access by preserving periodic face-to-face support and peer interaction. Systematic monitoring of access-related barriers and focused training in inclusive digital pedagogy for teachers should complement these measures to ensure that digital transformation improves quality without reinforcing existing inequalities.

The results of the observation show that the most effective learning model is a mixed format, which provides a balance between digital technologies and traditional learning. In groups that worked completely remotely, student engagement is noticeably reduced, especially in the long run. The main problems of distance learning are the lack of live interaction between students and teachers, reduced motivation due to the monotony of digital platforms, difficulties in adapting to new tools without proper support. Given these results, it is advisable to recommend expanding the possibilities of interactive learning in a digital environment and more actively introducing mixed teaching methods to improve the effectiveness of the educational process.

Leading universities of the world are actively implementing digital technologies, adapting the educational process to the requirements of the information society. This allows for learning flexibility, access to quality educational resources, and improved teaching efficiency. Many universities integrate digital platforms to support distance and blended learning. For example, the University of Manchester in the UK actively uses distance technologies to provide educational services to students from all over the world [20]. U.S. universities, such as the Georgia Institute of Technology, are also implementing online courses and programmes that allow students to get an education without having to be physically present on campus. Universities use a variety of digital tools, including LMS, virtual labs, and collaboration platforms. This contributes to the creation of an interactive and adaptive learning environment that meets the individual needs of students.

In the United States, educational institutions are introducing innovative methods such as blended learning, adaptive learning, and the use of big data to personalise the educational process. This allows you to increase the effectiveness of training and provide an individual approach to each student [21]. Problem-based learning methods and the use of open educational resources are popular in Europe. This contributes to the development of critical thinking and student independence. Asian countries, in particular, China and Japan, are actively integrating artificial intelligence and virtual reality technologies into the educational process, which allows creating more

interactive and exciting learning environments [22]. One prime example is the Coursera platform, created by Stanford University Professors, which provides access to online courses from the world's leading universities. This enables millions of students to receive a high-quality education, regardless of their location. Another example is the OpenClassrooms initiative in France, which offers online mentoring programmes that provide students with practical skills in demand in the labour market. In Singapore, the SkillsFuture programme uses digital platforms to provide citizens with lifelong learning and professional development opportunities. Thus, the introduction of digital technologies in higher education is a global trend that contributes to improving the availability and quality of education and the development of innovative teaching methods.

A staged and prioritised approach should be used to develop the digital learning environment based on the study's empirical findings, which include platform analysis, content evaluation, survey results, and observation data. In addition to addressing current operational issues, this strategy helps educational institutions build long-term institutional capability and a digital learning culture.

Short-term (Tactical measures): ensuring operational stability and immediate support: Eliminating organisational and technical obstacles that have a direct impact on the day-to-day educational process should be the top goal in the near future. A specialised technical support service, like a hotline or digital helpdesk, should be set up by educational institutions and run during regular business hours. Survey results showing that most respondents had technical issues with platform access and internet stability lend credence to this proposal. Quick technical support would boost user confidence in digital platforms and minimise disruptions.

A central repository of best-practice digital teaching resources, including recorded video lectures, methodological guidelines, assessment templates, and examples of successful course design, should also be established. This would reduce inconsistencies in course quality and enable instructors to adapt materials more efficiently for digital delivery. Short-term focused training sessions should complement this repository by familiarising teachers with fundamental interactive tools and core platform functions, such as course structuring, assignment workflows, and basic gradebook management, thereby addressing the operational competence gaps identified in the survey.

Medium-term (Strategic measures): strengthening institutional capacity: Ad hoc solutions should give way to systematic quality assurance at the medium-term level in educational institutions. Academic personnel should be required to complete a certification program in digital pedagogy that emphasises instructional design, online assessment, student engagement, and academic integrity in digital settings. Importantly, this programme should clearly differentiate between basic platform operation skills and advanced pedagogical competencies for digital environments, reflecting the qualitative finding that these domains represent distinct competence levels.

Basic training components should focus on reliable platform use, including consistent course navigation, communication tools, assignment submission workflows, and transparent grading procedures. Advanced modules should address pedagogical design for digital spaces, such as designing interactive assessments in Moodle using question banks and feedback logic, facilitating online discussions through structured prompts and moderation strategies, and creating interactive content using tools such as H5P (e.g., interactive videos, branching scenarios, and embedded formative checks). This distinction directly responds to respondents' concerns that technical familiarity alone does not ensure meaningful student engagement.

Institutions should also spend money on licensed interactive software that is integrated with learning management systems, like virtual laboratory tools or H5P for Moodle. The methodical development of interactive learning components, such as formative evaluation, cooperative exercises, and simulations, would be made possible by these technologies. The usage of these tools should be supported by institutional policies and regular assessments of learning objectives in order to guarantee efficacy.

Long-term (Cultural and systemic measures): sustaining digital transformation: Digitalisation ought to be incorporated into institutional growth plans throughout time. Institutions of higher learning are urged to create a structured blended learning plan that outlines the ideal ratio of in-person and virtual instruction for each subject. To ensure pedagogical coherence and adaptability, this approach should be in line with both international standards and national education policy.

Furthermore, sustaining innovation in digital teaching requires the cultivation of a community of practice among educators. Regular professional exchanges, mentoring schemes, and collaborative projects focused on

digital instruction would promote knowledge sharing and continuous improvement. Within such communities, experienced instructors could demonstrate effective practices in online discussion facilitation, interactive assessment design, and the pedagogical use of learning analytics to identify disengaged students and provide timely support. In parallel, long-term investment in digital infrastructure, equitable access to technology, and scalable platform solutions remains essential to ensure that the digital learning environment continues to support educational quality, equity, and institutional resilience.

4. Discussion

The results of the study confirmed the importance of the digital environment in ensuring the quality of training of specialists, which is consistent with trends in digital transformation of education. In the course of the analysis, it was determined that digital technologies not only contributed to improving access to educational resources but also increased the effectiveness of professional training through interactive and personalised approaches. One of the key results of the study was the confirmation of the positive impact of digital training on the development of professional skills. It is established that the use of digital technologies in the educational process contributes to the assimilation of theoretical knowledge and the formation of practical competencies, which is critical for the training of highly qualified specialists. Similar results are presented by Gokbulut and Durnali [23], who analysed the use of augmented and virtual reality in professional training. It has been proven that such technologies allow simulating real production processes and ensure effective assimilation of practical skills.

Comparing the results obtained with the data presented in a study by Marin et al. [24] confirmed the effectiveness of digital educational platforms in improving professional training. The authors proposed a new approach to teaching digital skills, focused on improving the quality of life, which proves the importance of digitalisation in shaping the competencies of future specialists. Similar conclusions were drawn by Mustofa et al. [25], having investigated the impact of digital technologies on the competitiveness of teachers in the labour market. The authors determined that the presence of developed digital competencies substantially increases the chances of graduates for employment and career growth. Thus, the results of the study are consistent with global trends in the digital transformation of vocational education and its adaptation to the requirements of the labour market. The study also highlighted those digital platforms substantially improve the quality of professional training, in particular, through adaptive learning opportunities. This aligns with the findings of Zhang et al. [26], who developed a methodology for assessing the quality of online education to improve the skills of teachers. It has been proven that digital platforms provide a personalised approach to learning, enabling the adaptation of the educational process to the individual needs of each student. This is especially important in the context of continuous professional development, where it is necessary to ensure the flexibility and availability of training materials.

According to the results of the study, there is a close relationship between the development of digital skills and the level of professional training. This thesis is supplemented by the paper of Audrin et al. [27], who investigated the importance of digital competencies for the labour market. Employees with a high level of digital skills were identified to demonstrate higher productivity, adapt faster to changes, and use the latest technologies more effectively in their professional activities. Similar results are found in a study by Speiser and Teiser [28], which analysed the role of digital technologies in creating learning environments based on digital doubles. The use of digital simulators in the educational process contributes to better assimilation of the material and improves the professional competencies of students, according to the authors. The results of the study also correlated with the statements of Lopes et al. [29], who assessed the effectiveness of digital skills in the public sector. The researchers proved that the success of employees largely depends on the level of their digital literacy, which makes digital competencies a necessary condition for effective professional activity in the labour market. Thus, the results obtained confirmed that digital technologies play an important role in professional training, contributing not only to improving the quality of education but also to increasing the competitiveness of graduates. This is in line with numerous international studies that prove the importance of digital competencies in the educational space and their direct impact on the professional development of specialists.

Analysis of the results of the study showed that the use of the digital environment in professional training contributes to increasing motivation to learn. This is due to the fact that digital technologies create an interactive learning environment that allows applying adaptive teaching methods, gamification, and personalised educational trajectories. Similar results are presented by Ouassam et al. [30], who modelled the digital educational environment and confirmed its effectiveness in training specialists. It was found that the introduction of digital technologies contribute to better interaction of students with educational materials, which positively affects the assimilation of knowledge and the formation of practical skills. Similar findings were presented by Osadcha et al. [31], who analysed the role of digitalisation in the professional training of specialists in the field of vocational education. A digital educational environment was demonstrated to help adapt the educational process in accordance with the requirements of the labour market, which increases the level of training of graduates and provides them with competitive advantages. A separate aspect of the analysis was the assessment of the impact of digital training on the development of professional competencies in specialised industries. For example, Pramila-Savukoski et al. [32] indicated that digital learning substantially improves the competencies of medical students. This demonstrates the versatility of digital technologies that can be effectively applied in various areas of professional training.

However, the study also pointed to certain challenges associated with the introduction of digital technologies in the educational process. In particular, the effectiveness of digital learning largely depended on the level of digital literacy of teachers. Insufficient training of teachers to work with digital platforms could become a barrier to the full realisation of the potential of the digital environment. This conclusion is supported by Stutchbury et al. [33], who analysed the impact of MOOC platforms on the professional development of educators. It was determined that although mass open online courses provide access to high-quality educational resources, their effectiveness depends on the level of digital literacy of users. The study also confirmed that digitalisation of education promotes the development of interdisciplinary competencies. The introduction of digital technologies allows using an integrated approach to learning, which contributes to the formation of students' comprehensive understanding of subjects and the ability to think interdisciplinary. This corresponds with the findings of Bilyakovska [34], who investigated the impact of digital technologies on the training of future teachers and found that the digital environment expands the possibilities of integrated learning, increasing its effectiveness. Thus, the results obtained confirm the importance of digitalisation of education as a means of increasing students' motivation, developing their professional competencies and forming interdisciplinary skills. The success of implementing digital technologies largely depends on the level of training of teachers and the availability of appropriate digital infrastructure.

An additional implication emerging from the study relates to the ethical dimensions of digitalisation. The responsible use of digital technologies requires not only technical optimisation but also strict adherence to principles of data security, privacy protection, and ethical AI application. Digital platforms must guarantee secure data storage and transparent privacy policies, while AI-based tools should support the learning process without replacing pedagogical judgement or compromising participants' autonomy. Therefore, the digital transformation of education should be implemented with clear regulatory frameworks that ensure cybersecurity, responsible use of data, and compliance with ethical standards in AI-supported learning environments [35].

In addition, the results of the study indicate the prospects of using meta-universes in professional training, which is consistent with the works of Onu et al. [36], Hrytsenchuk and Trubachev [37], who pointed out the potential of meta-universes in creating innovative learning environments. The study also demonstrated that digitalising education has the potential to generate critical thinking that coincides with findings of Aryee et al. [38], who explored the role of project activities in training specialists in a digital environment. However, some aspects require further research. In particular, the influence of the digital environment on the psychoemotional state of students should be examined in detail, which was only partially considered in the papers of Darling-Hammond et al. [39], Rêgo et al. [40], and Rohach et al. [41]. Thus, the results of the study confirmed the importance of the digital environment in the training of specialists, in accordance with international trends. As a result, several limitations were identified, which opens up prospects for further research, in particular, on the impact of digitalisation on the psychological comfort of students and the long-term effectiveness of digital technologies in professional training.

5. Conclusions

In the course of the study, a comprehensive analysis of the development of the digital educational environment and its impact on the quality of training of specialists was conducted. The main trends, advantages, and challenges of implementing digital technologies in the educational process are identified, and a comparative analysis of educational platforms, content analysis of educational materials, a survey of participants in the educational process and monitoring the effectiveness of using digital technologies in educational institutions. The study confirmed that the digital environment contributes to increasing the availability of educational materials, allows for personalised approaches to learning, and substantially expands the possibilities of interactive cooperation between students and teachers. Certain limitations and problems related to technical barriers, the need to adapt teachers to new teaching methods, and a decrease in the level of live communication in fully distance learning formats were identified. A comparative analysis of digital platforms showed that different systems have their own strengths and weaknesses. Moodle proved to be the most flexible due to its adaptability and open-source code, while Google Classroom and Microsoft Teams provide ease of use, but have limitations in customisation. Other platforms, such as Zoom with LMS integration, are more focused on synchronous learning, but do not always contain tools for integrated learning management.

Content analysis of training courses allowed establishing that the use of multimedia content and interactive tasks has a positive effect on the level of assimilation of the material. However, not all educational platforms offer a sufficient number of interactive elements, and some courses focus mainly on text materials without sufficient support for video lectures, simulations, and gamification. A survey conducted among 250 respondents (180 students and 70 teachers) demonstrated that 78% of respondents consider the digital environment effective for learning, but 43% noted an insufficient level of training of teachers to work in an online format. In addition, 65% of students stated that digital learning reduces the level of live communication, and 58% of teachers claimed that additional training is needed to use digital tools. Observation of the learning process has confirmed that the most effective model is blended learning, which combines traditional methods with digital technologies. The use of online testing and assessment tools allowed substantially optimising the work of teachers, but students who studied exclusively remotely showed a lower level of engagement and motivation.

Based on the results obtained, recommendations for improving the digital learning environment were developed. Among them were the need to improve the digital competence of teachers, expand interactive elements in training courses, introduce feedback mechanisms and personalised learning trajectories. It was also recommended to improve the regulatory framework to ensure high-quality implementation of digital technologies in the field of education.

Limitations of the study were related to the sample of respondents and the specifics of the analysed platforms. The research was conducted as a single-institution case study, focusing on one higher education institution, which allows for an in-depth examination of the digital educational environment in a specific context but limits the generalisability of the findings to other universities, regions, or cultural and technological settings. The results can be refined in further studies that will cover a wider range of educational platforms, including industry-specific solutions. In addition, the sample size of 250 respondents from a single university restricts broader generalisation.

Future research should involve multi-institutional and cross-national comparative studies with larger and more diverse respondent groups. Such an approach would allow validation and comparison of the findings across different educational systems and enhance the representativeness and robustness of conclusions regarding the digital learning environment. Also, future research should employ a longitudinal design to assess the long-term effectiveness of digital training beyond immediate educational outcomes. Tracking graduates at 6, 12, and 24 months after programme completion would make it possible to evaluate career advancement (employment status, time-to-first job, promotion or role expansion, alignment between job position and field of study) as well as the sustained application of acquired skills in professional settings, including the use of digital tools, problem-solving abilities, teamwork, and self-regulation. Such an approach would allow identifying which elements of the digital educational environment contribute most to durable professional competencies and successful labour-market integration, thereby strengthening the evidence base for strategic decisions in the digital transformation of higher education.

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