

The role of ICT in education: Comparing virtual and traditional learning methods



Svitlana Karpluk^a   | Iryna Moyseyenko^b  | Tetiana Lysenko^c  | Olena Moroz^d  |
Oksana Protas^e 

^aDepartment of Social Sciences and Fundamental Training, Zhytomyr Institute of Private Joint-Stock Company «Higher Educational Institution», Interregional Academy of Personnel Management, Zhytomyr, Ukraine.

^bDepartment of Germanic and Finno-Ugrian Philology, Faculty of Germanic Philology and Translation, Kyiv National Linguistic University, Kyiv, Ukraine.

^cDepartment of Analytical, Physical and Colloid Chemistry, Pharmaceutical Faculty, Bogomolets National Medical University, Kyiv, Ukraine.

^dNavigation Department, English Language Department for Deck Officers, Kherson State Maritime Academy, Kherson, Ukraine.

^eDepartment of Social Pedagogy and Social Work, Faculty of Pedagogy, Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine.

Abstract With the development of information and communication technologies, online learning has become critically important, especially in the COVID-19 pandemic, which requires rapid adaptation of educational systems to new conditions. The article aims to compare the effectiveness of online and offline learning modes in developing students' key competences and identify the advantages and disadvantages of each approach to optimise educational processes in modern conditions. To conduct a comparative analysis of online and offline learning modes, data was collected from 80 students divided into two groups: traditional (20 first and 20 fourth-year students) and online (20 first and 20 fourth-year students). The analysis showed that online learning has a positive effect on students' academic achievement ($d = 0.77$) and motivation ($d = 0.69$) due to access to resources and flexible schedules and less pronounced improvements in technical ($d = 0.28$) and organisational ($d = 0.33$) skills. Instead, social skills ($d = 0.03$) develop more slowly due to the limited interaction between students and teachers in the online environment. Online learning is more effective in improving student performance and motivation. A comparative analysis of offline and online education modes has shown that offline learning contributes to developing social and communication skills but complicates ensuring student motivation. In contrast, online learning improves the quality of learning outcomes and professional skills through access to platforms and flexible learning schedules. However, it may reduce social skills due to limited interaction. The choice between modes of learning should consider students' educational goals and needs, and the integration of ICT can create a more effective learning environment.

Keywords: information, digital tools, traditional education, distance learning, educational environment, adaptive learning

1. Introduction

Modern education is undergoing profound transformations driven by the rapid development of information and communication technologies (ICT). In recent years, online learning has become an essential part of the educational process, offering new opportunities for acquiring knowledge and developing skills. However, despite the growing popularity of online modes, traditional offline learning methods continue to play a significant role in the educational environment. As the number of educational institutions integrating ICT into their programmes increases, it is essential to carefully evaluate the effectiveness of different educational modes. Online learning offers flexibility, access to a wide range of resources, and the ability to self-pace learning. However, traditional offline methods provide direct contact with teachers and fellow students, positively impacting the socialisation and development of students' communication skills.

This research article aims to compare the use of information and communication technologies (ICT) in the educational process by correlating online and offline learning modes. It seeks to analyse how different learning modes affect students' educational outcomes, including their academic achievements, technical skills, social and communication skills, self-organisation skills, motivation, and engagement.

Education is a critical factor in economic and social progress in any society. In the context of global digitalisation, which covers all aspects of modern society, integrating information and communication technologies (ICT) not only changes traditional teaching methods but also opens up new opportunities to study their effectiveness in improving the quality of the educational process (Amutha, 2020). Despite the general concern of educational stakeholders about the quality of online education, due to doubts about the adaptation of a significant number of teachers to the online format and the availability of resources to implement the necessary technologies in the learning process (Adu et al., 2023; Vasta & Prenko, 2022; Che et al., 2022; Şenol et al., 2021), the use of advanced technologies in education is a critical factor in its effectiveness in developing the necessary skills of students to ensure their further development in professional activities. Nonetheless, certain scholars emphasize the significance of ICT integration rather than the replacement of conventional educational procedures. In particular, in Khan (2023), ICT integration refers to the result of introducing ICT into teaching and learning for a meaningful



outcome that might not have been achieved without the use of ICT, while replacement is the replacement of traditional teaching with digital technologies. The author notes that training teachers to use technology in many ways contributed to a false sense of achievement, leading teachers to believe that they were integrating ICT, when in fact they were merely replacing aspects of classroom teaching with ICT. The expediency of transitioning educational institutions to an online learning format is mainly due to the possibility of applying innovative approaches and information and communication technologies (ICT) to the curriculum, which will allow the development of technical skills (Holik et al., 2023), analytical thinking, critical thinking, information literacy, self-motivation and self-management (Nikukar, 2024), communication skills, teamwork and critical thinking, as well as stimulate students' intrinsic motivation and creativity (Braievskaya, 2024; Dhivya et al., 2023; Ong & Annamalai, 2024). Currently, the world's leading universities use video conferencing platforms, learning management systems, digital libraries, virtual laboratories, and multimedia content creation tools to ensure the high quality and efficiency of online education, contributing to the development of the necessary skills and competences in students (Cantrell, 2022; Chiekezie & Okafor, 2024; Odili et al., 2020). For example, in the United States, curricula such as Summit Learning, K12, and Edgenuity effectively integrate traditional and online learning, providing flexibility and personalisation, in particular, to achieve a high level of digital literacy and maintain flexibility in the educational process (Bozkurt et al., 2020); and the Quercus online learning system, which operates based on the Canvas learning management system, is used, which allows the institution to organise the learning process effectively, provide flexibility in the choice of teaching methods, support the interactivity of courses, and promote individualisation of learning according to the needs of students (Dionisio, 2023). Thus, studying the effectiveness of the online approach in the educational context will ensure more efficient use of digital tools, which, in turn, will help improve the quality of educational processes and professional training of students.

2. Materials and Methods

In the course of the research, the following general scientific methods were utilised: the analysis of literary sources was used to identify the validity of the selected criteria for evaluating learning outcomes; comparative analysis was applied to determine the differences and similarities between the two forms of learning and assess their impact on various aspects of the educational process; the method of systematisation allowed for the classification of data according to the main criteria, which facilitated the process of analysis and the integration of information into the overall context of the study; the method of generalisation was used to formulate general conclusions about the effectiveness of different forms of learning.

In order to conduct a comparative analysis of online and offline learning modes, critical criteria were identified, including academic achievement, technical skills, social and communication skills, self-organisation skills, motivation and engagement. The study used a sample of 80 participants divided into two main groups to assess the level of student's academic performance: the first group includes first-year (20) and fourth-year (20) students who have a traditional form of study; the second group includes first-year (20) and fourth-year (20) students who study online. The sample was formed to ensure the representativeness of the assessment results and to identify changes in academic performance, professional skills and motivation during the study.

To determine the level of academic achievement, the average score of students for the academic year was applied. The tutor assessed the students' technical skills in terms of practical skills on a 100-point scale. The Mehrabian Achieving Tendency Scale (MATS) was used to measure the level of motivation and engagement in the learning process, and the assessment of communication skills and organisational skills was carried out using the Communication Skills and Organisational Skills Diagnostic (KOS-2). Based on the data obtained, weighted average scores for each criterion were calculated using the "AVERAGE" function in Excel. Further application of statistical methods in the JASP program, such as Paired Samples T-Test and Cohen's *d*, allowed us to determine the significance of differences between groups and assess the effect of different forms of training on the development of key competences. The statistical analysis ensured the conclusions' objectivity and confirmed the study results' practical significance.

3. Results

The modern development of information and communication technologies (ICT) has significantly influenced the transformation of the educational process; in particular, it has contributed to the active implementation of online learning. In economically developed countries, a favourable environment for transforming education through successful ICT adoption is provided mainly by high levels of infrastructure support, widespread Internet access and effective measures to increase digital literacy among students and teachers (Okoye et al., 2023). However, the challenges of economically disadvantaged areas, such as the lack of adequate infrastructure, limited availability of technological devices, and insufficient training programmes for educators, are still relevant, highlighting the urgency of targeted measures to bridge the digital divide. The concept of 'school digital climate' (SDC) provides a critical assessment framework for identifying specific infrastructural, pedagogical and institutional factors that facilitate or hinder ICT integration in different socio-economic settings (Khan, 2023). These factors include the availability of technical resources; access to online resources; the level of digital literacy of teachers; their ability to

use technology effectively to enhance learning; the level of support from educational institutions and policy makers; and the legal and regulatory frameworks governing the use of ICT in education.

Different capabilities and levels of ICT integration also depend on the cultural context, which further modulates the adoption and effectiveness of online learning technologies. In societies that favor technological innovation and demonstrate a high level of digital readiness, ICT is perceived as a key tool for improving educational outcomes (Alam et al., 2024). Conversely, traditionalist cultures or cultures with limited access to digital technologies may be resistant to such innovations, making their integration more difficult. The SDC framework, along with indices such as the Technology Pedagogical and Content Knowledge (TPACK) model, emphasizes the need to tailor ICT interventions to cultural dispositions and pedagogical traditions (Rasdiana et al., 2024). For example, in South Africa, Baako & Abroampa's (2024) research found that successful ICT integration in socioeconomically disadvantaged schools depends not only on the availability of resources, but also on ongoing professional development for teachers and alignment of technological tools with culturally relevant teaching practices.

Distance learning is now becoming an effective alternative to traditional methods, especially in the face of global challenges such as natural disasters, the COVID-19 pandemic, armed conflicts, etc. The main advantages of online learning focused on the use of ICT and the acquisition of digital competences among students, identified in the scientific literature, are the ability to independently formulate and adjust educational tasks, which allows one to adapt the learning process to the individual needs and interests of students (Makhsma & Kozlov, 2023). In addition, the distance format provides access to a wide range of information resources, which contributes to deeper and more comprehensive learning of the educational material (Loban et al., 2021) and the possibility of expanding communication between students, teachers and other participants in the educational process, regardless of their geographical location, which increases the interactivity and effectiveness of learning, as well as increases the level of student engagement (Pavlenko, 2024). Given these trends, it is essential to conduct a comparative analysis of the skills of students studying in different forms to determine the degree of influence of each of them on the results of the educational process.

3.1. Educational outcomes of offline students

The study of the assessment of skills of traditional students is essential for understanding the effectiveness of the classical educational model in developing key competences. The following criteria for assessing the learning outcomes were identified: academic achievements, technical skills, social and communication skills, self-organisation skills, motivation and engagement. The skills were analysed among 40 students in the first (20) and last (20) years of study to identify changes in academic performance, professional skills and motivation. In the course of the assessment, the level of academic achievement is determined by the current academic performance; in particular, the average score of students for the academic year was used for the analysis, while the curator of each group assessed students' technical skills on a 100-point scale. In addition, the Mehrabian Achieving Tendency Scale (Aghaz & Salmasi, 2024; Berdnikova, 2018; Mehrabian & Bank, 1978) was used to identify the level of students' motivation and involvement in the learning process and the KOS-2 methodology (Baldyniuk, 2024; Ivanchenko et al., 2021; Kovalchuk & Yermak, 2021) to diagnose communication skills and organisational skills. As a result of calculating the weighted average scores for each of the criteria, the results were grouped in Figure 1.

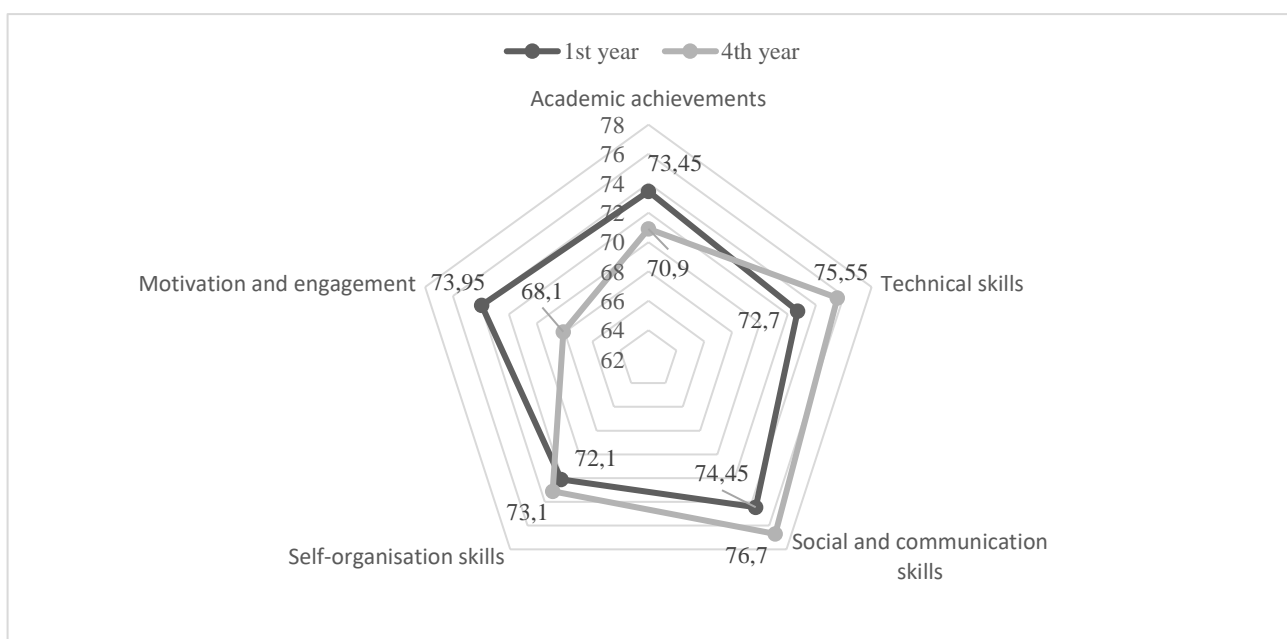


Figure 1 Assessing skills of students of traditional forms of education.

Comparative analysis of academic performance and skills development among first and final-year students shows that the offline learning process hurts the level of motivation and engagement of students in the learning process (1st year = 73.95; 4th year = 68.1). The decline in motivation in the traditional approach is mainly due to study fatigue, changing student priorities and insufficient consideration of students' individual needs and interests, which also affects their interest in academic achievement (1st year = 73.45; 4th year = 70.9). Instead, the increase in average scores for technical skills (1st year = 72.7; 4th year = 75.55) results from constant access to practical classes and laboratories, which allows students to acquire and improve their knowledge. In addition, the acquisition of communication skills (1st year = 74.45; 4th year = 76.7) and self-organisation (1st year = 72.1; 4th year = 73.1) by traditional students indicates that offline learning promotes interaction and teamwork among students and increases their level of responsibility in the performance of educational tasks. To prevent a decrease in student motivation during the educational process and to ensure a high level of academic performance, it is necessary to consider current trends and conditions in which educational institutions operate. The spread of blended and online learning modes and the intensity of digitalisation in this context contribute to transforming approaches to educational goals. Using modern ICT tools, such as virtual laboratories, interactive platforms and multimedia materials, allows for a more flexible and adaptive learning environment that meets students' individual needs and promotes their active involvement in the learning process. In other words, achieving a high level of student motivation and success is associated with the need to replace outdated approaches to the educational process with modern online equivalents, taking into account the relevance of ICT and other new technologies.

3.2. Educational outcomes of offline students

The analysis of educational outcomes and acquired skills of online students is essential for understanding the effectiveness of the distance education model in developing key competences, which were used as research criteria. The survey was conducted among 40 students of higher education institutions enrolled in the first (20 people) and last (20 people) year of study. This allowed us to identify changes and trends in academic performance, professional skills and motivation. The research methods used to obtain the grades were identical to the analysis of offline students. By calculating the weighted average scores for each criterion, the impact of online learning on student development and the advantages and disadvantages of using modern technologies in the educational process were identified. The results are shown in Figure 2.

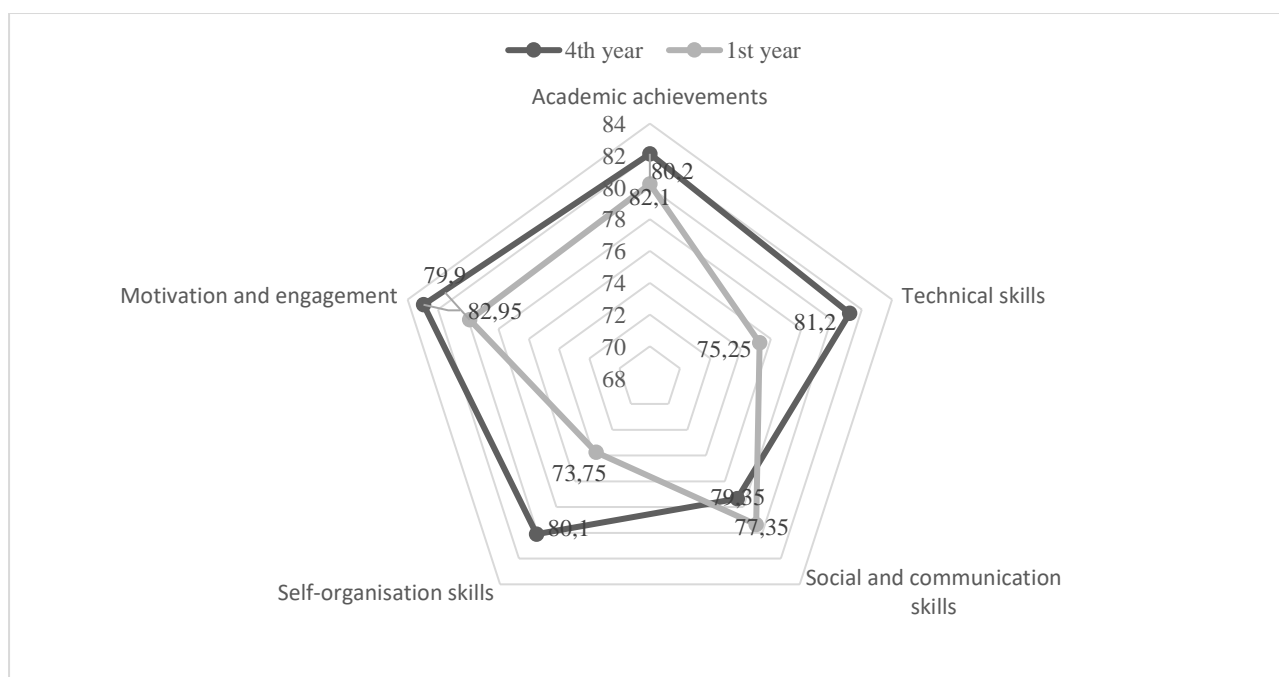


Figure 2 Assessing skills of online learning students.

Despite a decrease in the level of socialisation (1st year = 79.35; 4th year = 77.35) of students due to limited opportunities for personal communication and interaction in the online environment, organisational skills (1st year = 73.75; 4th year = 80.1), including planning, self-discipline, adaptability and time management, are improving due to a flexible and personalised approach to online lectures and the use of various digital tools in the learning process to optimise work on tasks. The improvement of academic results of online students (1st year = 80.2; 4th year = 82.1) is associated with access to a wide range of resources and the ability to control the pace of learning independently and, in addition, their high motivation (1st year = 79.9; 4th year = 82.95) in gaining professional knowledge. In this context, the quality of the technical skills acquired (1st year



= 75.25; 4th year = 81.2) and the use of ICT and flexible learning schedules contribute to the growth of students' interest and activity during the educational process.

3.3. The magnitude of the effect of the study mode on educational outcomes

The comparative analysis of online and offline modes of study is based on assessing the effect of the mode of study on student outcomes according to predefined criteria. The analysis included online students (Group 1 = 40 people) and traditional students (Group 2 = 40 people) in the first and last years of study. The Student's t-test was used to compare the educational process results for the two groups of students. The tool used for the analysis is the Paired Samples T-Test, conducted using the JASP statistical analysis software (Fitts, 2020; Malsakpak & Pourteimour, 2024; Moore & McCabe, 1989). In addition, to estimate the effect size, the framework calculated Cohen's d, which reflects the effect size and helps to understand the practical significance of differences between groups (Goulet-Pelletier & Cousineau, 2018; Martin et al., 2022; Ramanathan et al., 2024). The results of the comparative analysis are presented in Table 1.

Table 1 Measuring the effect of online learning on the educational process.

Paired Samples T-Test					
Criteria	T	df	p	Cohen's d	SE Cohen's d
Group 1					
Academic achievements	1.680	19	0.945	0.376	0.296
Technical skills	0.531	19	0.699	0.119	0.249
Social and communication skills	0.852	19	0.797	0.190	0.325
Self-organisation skills	0.278	19	0.608	0.062	0.309
Motivation and engagement	0.880	19	0.805	0.197	0.384
Group 2					
Academic achievements	3.431	19	0.999	0.767	0.347
Technical skills	1.267	19	0.890	0.283	0.313
Social and communication skills	0.129	19	0.551	0.029	0.316
Self-organisation skills	1.496	19	0.924	0.335	0.279
Motivation and engagement	3.123	19	0.997	0.698	0.312

The analysis results demonstrate differences in the impact of a particular form of education on developing these skills. This allows us to conclude the effectiveness of traditional and modern teaching methods in obtaining higher education. The areas of influence of the form of education on the defined assessment criteria for two groups of students are shown in Figure 3.

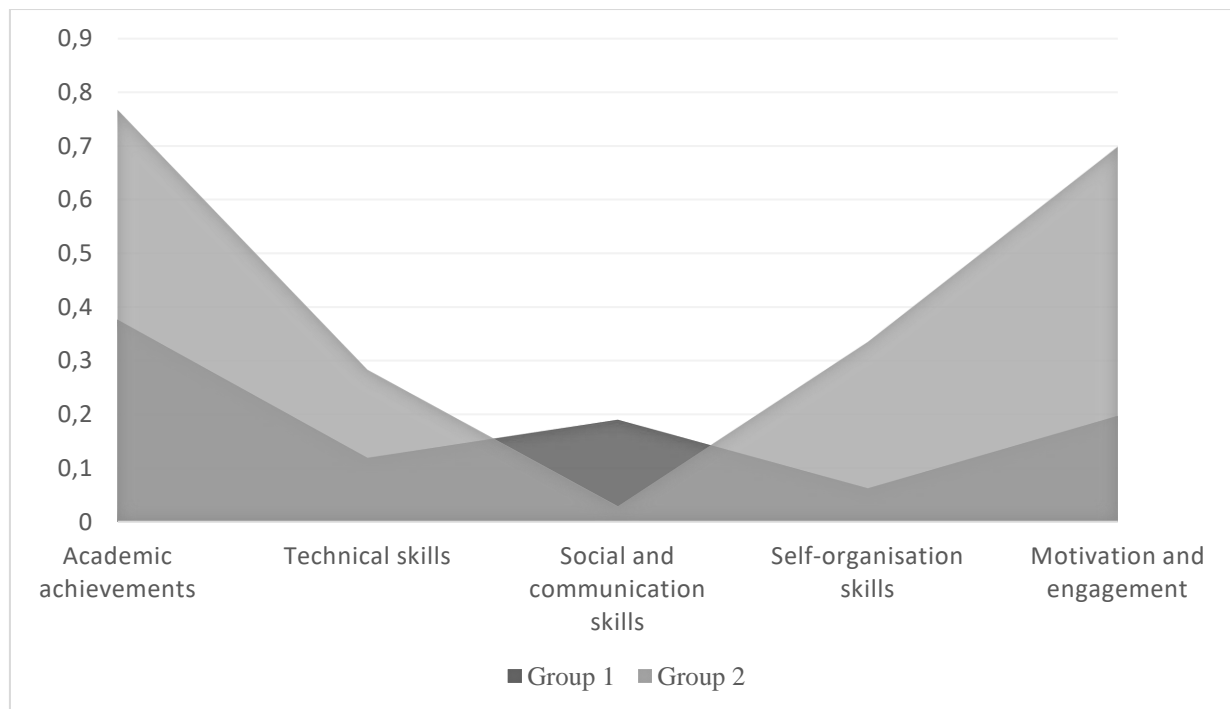


Figure 1 Effect of the education mode on developing key skills.

The results of the analysis show that the online mode of learning has a significant positive impact on student's academic achievement ($t = 3.43$ at $p = 0.99$) and motivation ($t = 3.12$ at $p = 0.99$), which is due to the possibility of access to a large amount of additional learning material and interactive content, as well as the flexibility of the curriculum. In addition, students' technical ($t = 1.27$ at $p = 0.89$) and organisational ($t = 1.49$ at $p = 0.92$) skills in online learning have a positive, though less pronounced effect, due to the greater dependence on digital tools on the one hand, and the need to plan and manage their learning process on the other. However, social and communication skills ($t = 0.13$ at $p = 0.55$) develop slowly and, in some cases, degrade due to the limited interaction between participants in the educational process in the online environment. That is, after the goals of the educational process are achieved, the magnitude of the effect of distance learning and digital tools generally increases, in particular in terms of academic performance ($d = 0.77$) and motivation ($d = 0.69$), which indicates the potential of such teaching methods to improve the efficiency of the educational process and adapt students to modern learning conditions and labour market requirements.

4. Discussion

In the modern educational paradigm, the online learning format is becoming an essential factor that significantly transforms traditional educational practices. The use of an online learning format provides students with the opportunity to formulate educational goals independently, which allows them to personalise the learning process according to their individual needs (Makhsma & Kozlov, 2023), which in turn provides access to a wide range of information resources, which is essential for independent learning and the development of critical thinking (Loban et al., 2021). In addition, the ability to use many learning resources and communicate with other participants in the process, regardless of their geographical location, is a significant factor that facilitates the integration of knowledge and the exchange of experience in the context of globalisation (Pavlenko, 2024). Despite these advantages, specific difficulties are associated with transitioning to an online learning format. As noted by researchers such as Adu et al. (2023), Vasta & Prenko (2022), Che et al. (2022), and Şenol et al. (2021), certain negative attitudes towards online education are due to insufficient adaptation of teaching staff to the need to digitalise the educational process, limited resources, and general distrust of the quality of learning in the online environment. In this context, Marchisotti et al. (2022) found that 78% of respondents have a prejudice against distance learning, and the main reasons are perceptions of poor teaching quality, lack of trust in the educational process, lack of knowledge about this method of learning and resistance to the new one.

However, the study confirms the priority of transition of educational institutions to distance or blended learning due to the significant development of students' critical skills, in particular, the improvement of academic results of online students over four years of study (1st year = 80.2; 4th year = 82.1) and their high motivation (1st year = 79.9; 4th year = 82.95) in gaining professional knowledge. Also, taking into account the analysis of the magnitude of the effect of the online learning mode on the educational process, this format is inferior to the traditional approach only in the field of socialisation and development of communication skills ($d_{\text{Group1}} = 0.19$; $d_{\text{Group2}} = 0.03$), while the relationship between academic performance ($d_{\text{Group2}} = 0.77$) and motivation ($d_{\text{Group2}} = 0.69$) is justified by the significant prevalence of indicators of online students. Thus, despite the existing difficulties, integrating advanced technologies into online education opens up new opportunities for improving the learning process. Information and communication technologies, such as collaborative platforms, virtual laboratories, and online discussion tools, can significantly improve learning efficiency by promoting the development of communication skills, teamwork, and critical thinking (Braievska, 2024; Dhivya et al., 2023; Ong & Annamalai, 2024). In particular, these technologies allow for the development of analytical and cognitive activity, critical thinking, information literacy, self-motivation and self-management skills (Nikukar, 2024).

The findings of our study are consistent with the conclusions of Khan (2023), who substantiate the need to provide appropriate material and technical resources and implement systematic professional development of teaching staff for the successful integration of ICT into the educational environment. As in our study, their work emphasizes the critical role of organizational and managerial support and adaptation of ICT to the contextual features of individual educational institutions. At the same time, the authors' concept of "school digital climate" (SDC) allows us to identify specific factors that facilitate or, conversely, hinder the effective integration of technology, which is consistent with our findings on the impact of contextual factors on the effectiveness of digital transformations. Thus, the findings confirm the need for an interdisciplinary approach to the implementation of digital innovations, as well as the relevance of using standardized tools for assessing the digital readiness of educational institutions, which are key to ensuring their adaptability and efficiency in the modern technological environment.

An important aspect is also the improvement of technical skills, including methodological and research skills, which are critical for the successful implementation of the tasks of the educational process (Holik et al., 2023). Thus, despite the existing challenges and criticisms, online education has significant potential for developing students' key competences. Further research should focus on improving digital learning tools, optimising interactive methods and overcoming existing problems to ensure high-quality education in the online environment, as systematic improvement of technological infrastructure and pedagogical practices can achieve high standards of the educational process and ensure the sustainable development of critical skills and learning outcomes of students in the context of digitalisation.

5. Conclusions

A comparative analysis of offline and online education highlights significant differences in their impact on educational outcomes and the development of student skills. The results of the study indicate that traditional offline learning has a positive impact on students' social and communication skills through face-to-face communication and group interaction. However, the analysis also demonstrates problems with student motivation and engagement, which can decline in the course of education due to fatigue and insufficient adaptation of curricula to individual needs. On the other hand, online learning shows significant potential to improve academic achievement, thanks to the broad access to learning platforms and the ability to self-regulate the pace of learning. The flexibility and personalised approach to online education contribute to improving technical and organisational skills. However, it should be noted that social skills are likely to be reduced due to limited face-to-face interaction. In general, the results of the analysis show that the choice between offline and online forms of education should consider the specifics of learning objectives and individual needs of students. Integrating modern ICTs into learning is essential to create a more adaptive and effective educational environment. Prospects for further research include an analysis of blended learning and its impact on student's academic and professional outcomes, which will help achieve an optimal balance between traditional and modern education methods.

Ethical Considerations

We confirm that we have obtained all consent required by applicable law to publish any personal details of research participants. We agree to provide Multidisciplinary Reviews with copies of the consent or evidence that such consent was obtained if requested.

Conflict of Interest

The authors declare no conflicts of interest.

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