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Enhancing the effectiveness of learning through hybrid education methods

Mejorar la eficacia del aprendizaje mediante métodos de educación híbrida

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Abstract

Blended learning is seen as a symbiosis of traditional and innovative pedagogical practices against the background of active digitalisation of the educational environment. The article aims to analyse the role and impact of blended learning on the effectiveness of the educational process. In the course of the study, theoretical (analysis, synthesis, generalisation) and empirical (experiment, observation, description) research methods were used, as well as generalisation. The calculation of the effectiveness indicators of



the educational technology of blended learning for the experimental and control groups was implemented using the Student's t-test. The study results showed that the use of blended learning techniques contributes to students' effective accumulation. It is also established that the concept of blended learning positively affects the communication of participants in the educational process, contributing to a positive atmosphere and a sufficient level of motivation to learn. The proposed concept covers several innovative tools, including online platforms, stimulating practices, adaptive individualised learning technologies, and practice-oriented and problem-based learning. In this study, the empirical value of the Student's t-test t (19.5) is within the zone of significance, which means that the proposed technology is effective. In general, interpreting the confirmatory represents the effectiveness of blended learning methods.

Keywords: blended learning, forms of the educational process, innovative pedagogical technologies, online communication, integration, success rate.

Resumen

El aprendizaje combinado se considera una simbiosis de prácticas pedagógicas tradicionales e innovadoras en el contexto de la digitalización activa del entorno educativo. El artículo pretende analizar el papel y el impacto del aprendizaje combinado en la eficacia del proceso educativo. En el transcurso del estudio se utilizaron métodos de investigación teóricos (análisis, síntesis, generalización) y empíricos (experimento, observación, descripción), así como de generalización. El cálculo de los indicadores de eficacia de la tecnología educativa de aprendizaje combinado para los grupos experimental y de control se llevó a cabo mediante la prueba t de Student. Los resultados del estudio mostraron que el uso de técnicas de aprendizaje semipresencial contribuye a la acumulación efectiva de los alumnos. También se establece que el concepto de aprendizaje combinado afecta positivamente a la comunicación de los participantes en el proceso educativo, contribuyendo a crear una atmósfera positiva y un nivel suficiente de motivación para aprender. El concepto propuesto abarca varias herramientas innovadoras, como las plataformas en línea, las prácticas estimulantes, las tecnologías de aprendizaje individualizado adaptativo y el aprendizaje orientado a la práctica y basado en problemas. En este estudio, el valor empírico de la prueba t de Student (19,5) está dentro de la zona de significación, lo que significa que la tecnología propuesta es eficaz. En general, la interpretación del confirmatorio representa la eficacia de los métodos de aprendizaje combinado.

Palabras clave: aprendizaje combinado, formas del proceso educativo, tecnologías pedagógicas innovadoras, comunicación en línea, integración, tasa de éxito.

Introduction

The active introduction of distance and blended learning during the pandemic has stimulated the transformation of the educational environment globally. Blended learning, which involves a combination of offline and online forms of education based on the principles of mutual complementarity, is characterised by a duality of purpose. Blended learning stimulates the involvement of students in group learning activities, which increases communication competence and interaction skills. Blended learning aims to individualise the educational process, where everyone feels their influence on the results and can express their creativity and will to the maximum. Within the concept of blended learning, teachers are assigned the role of a creative tutor, facilitator, and organiser of the learning process. He or she should be open to interactive forms of work, understand their effectiveness, and purposefully implement them in practice.

Scientific publications of modern authors focus on topical issues of implementing a blended learning system. Thus, the functionality of the methodology is revealed in the research of Batista-Toledo & Gavilan (2022).



Some scholars (Sytnik, 2021) analyse the possibilities of improving the quality of education using innovative digital technologies. At the same time, Hurevych et al. (2023) argue that interactive and mobile learning has become a necessary component of the educational process today.

Blended learning technologies are effective in interactive forms of work (Abbacan-Tuguic, 2021) and practice-oriented education (Belova, 2023). Ando et al. (2022) suggest using situations and events in the learning process that are as close as possible to the reality of students' future professions. At the same time, hybrid curricula allow for in-depth research in a remote format while being based on the principles of interaction and cooperation.

Blended learning significantly expands the boundaries of students' development and self-affirmation, develops several necessary competences, and contributes to increased competitiveness in the labour market (Kusmaryono et al., 2021). Another undoubted area of blended learning success is the development of adaptability, continuous learning and self-development, emotional intelligence, and critical thinking skills in students. At the same time, the primary functionality of blended learning is focused on student achievement. Therefore, the study aims to analyse the role and impact of blended learning on the effectiveness of the educational process.

To achieve this goal, several research tasks need to be completed:

- To analyse the role of blended learning in improving students' academic performance
- To investigate the effectiveness of the use of blended learning using a pedagogical experiment
- To summarise the role of blended learning in improving the efficiency of the educational process.

This study focuses on analyzing the role and impact of blended learning on the effectiveness of the educational process. The study used theoretical (analysis, synthesis, generalization) and empirical (experiment, observation, description) research methods, as well as generalization. The literature review describes the main methods and forms of implementing the blended learning strategy and the specifics of their integration into the traditional learning environment. The results include the calculation of the effectiveness indicators of blended learning educational technology for the experimental and control groups using the Student's t-test, proving that the use of blended learning methods contributes to the effective accumulation and use of knowledge and skills by students. The discussion examined how interactive forms of educational interaction, project-based learning, and online platforms, which are actively used in blended learning, can significantly influence student performance and the achievement of educational goals. The conclusions summarize the achievements, gaps, and challenges of the current study and identify promising areas that the study aims to address in higher education through hybrid learning.

Literature Review

The primary trend in the global transformation of the educational process is the integration of distance learning, digitalisation tools and online communication. Modern researchers are actively developing the field of this issue. In particular, Baral & Baral (2021) substantiate the potential of interactive technologies.

The scientists are convinced that a modern specialist in demand can be formed in the educational field through a combination of individual and group forms of work, maximum integration of discussion practices, project-based learning and training, including online.

The pedagogical experiments of Bojović et al. (2020) prove a direct link between interactive work methods and academic performance. Thus, the Case-study method not only effectively develops professional practical skills but also promotes critical thinking and problem-oriented search for targeted solutions to a situation. At the same time, elements of virtual reality in the form of immersive simulations allow students to engage the cognitive sphere and reflect, forming their sustainable competence skills.



Ghazali (2022) and Mae et al. (2023) demonstrate the positive experience of blended learning in the context of students' academic performance and achievements. The researchers note that ensuring a sustainable positive effect requires developing educational and methodological support for the process that will stimulate motivation, independence, and interest in the subject among students. At the same time, students can co-author the learning process, not just to gain a high level of knowledge.

Gamification and mobile learning elements are innovative areas of blended learning. According to Kaplan et al. (2021), Bulhakova & Zosimov (2023), game collaboration increases learning motivation and promotes better learning. Mobile applications allow for optimising the spatial and temporal aspects of the educational process. During the time allocated for offline classes, Bulhakova & Zosimov (2023) suggest discussing complex aspects of the learning material or practicing basic skills. At the same time, the online format should be used to expand knowledge and skills in key areas using educational online platforms, mobile applications, and virtual conferences. This ensures unimpeded feedback from the instructor. Kaplan et al. (2021) argue that the integration of the interactive panel method allows for the organization of learning in which all participants receive the same information but choose their own time to assimilate the learning content. Students can view the interactive material an unlimited number of times.

A number of modern researchers focus on individualising the educational process (Dzhejera, 2023; Linnik, 2023), while other scholars (Abbacan-Tuguic, 2021) focus on eliminating the imbalance between innovative and traditional forms of education. Dzhejera (2023) argues that the implementation of the blended learning concept allows for the integration of a practice-oriented strategic focus with the requirements of future professional activities. Discussions, coaching, and business games are considered particularly relevant in this format. Linnik (2023), in turn, draws attention to the advantages of developing universal soft and digital skills necessary to ensure the competitiveness of future specialists. Abbacan-Tuguic (2021), through observations and experimental research, highlights the importance of blended learning in ensuring a high level of motivation among participants in the educational process, while emphasizing the need to select tools and methods appropriate to the age group and professional field.

The publications of Ilinitska et al. (2023) show a strong belief that the effectiveness of blended learning in the context of academic performance depends on the effectiveness of managing various forms of interaction between participants in the educational process. At the same time, it is advisable to increase students' motivation through effective structuring of the learning process, unhindered feedback, emotional intelligence and creativity. In continuation, Dean & Mansour (2016) draw attention to the need to optimise the psychological environment of the educational process through positive-pole communication in face-to-face classroom consultations and online conferences.

The literature review found that a number of aspects of blended learning are insufficiently researched. In particular, the ways of preserving the functional content of the educational process within the concept of blended learning and the practical aspects of implementing the studied methodology require an extended analysis.

Methodology

The study used a combination of theoretical and empirical methods. The methodology was developed to systematically and objectively analyse blended learning educational practices. A qualitative research design, which focuses on analysing existing concepts of blended education, was applied.

The research procedure consisted of the following main stages: collecting and analysing theoretical data, conducting a pedagogical experiment, and formulating generalisable conclusions.

In the first stage, a critical review of industry publications was carried out to identify key innovative practices, trends and challenges in the field of research. The inclusion and exclusion criteria were the level of information reliability and the spatial and temporal indicators. Priority was given to publications indexed in

the leading scientific databases Scopus and Web of Science. Publications for the period 2020–2024 were selected. A brainstorming method was used to assess the risk of bias in the included studies.

To process theoretical data, a number of general scientific methods were used, including analysis and synthesis (to study modern educational concepts and clarify terminology), comparison (to systematise conceptual approaches to blended learning and identify related risks and obstacles), and structural and logical methods (to develop proposals).

In the second stage, a pedagogical experiment was conducted with higher education students for one academic month. The control group consisted of 31 students, and the experimental group consisted of 33. The control experiment was conducted to evaluate the effectiveness of the proposed elements of blended learning using the Student's t-test.

The research was conducted in real teaching conditions with the knowledge of the teaching staff.

The criteria for selecting respondents were: representativeness of participants and their ability to attend classes regularly to ensure the reliability and completeness of the experiment.

The duration of the study was one month, as a necessary condition for the success of experimental research is its connection with practice. Its specificity is determined by the unevenness of the processes and the unpredictability of their results. The one-month study is designed to obtain comprehensive data on the dynamics of the phenomenon under study, taking into account the conditions. The results of experimental research in the field of education usually require lengthy verification, as they are not immediately apparent. Therefore, one month is the recommended period for implementing significant innovations in pedagogical practice in order to draw conclusions about their effectiveness.

The participants provided their informed consent. The confidentiality of the research results was also ensured.

To identify the initial level of effectiveness of the skills and knowledge of the experimental and control groups, we used the learning coefficient, which is determined by formula (1):

$$KN1 = A1/N1 \quad (1), \quad (1)$$

where KN1 is the learning coefficient, A1 is the qualitative indicator of learning outcomes, and N1 is the maximum possible number of points for the result of quality training.

To optimise the learning process, online platforms, practice-oriented and problem-based learning, and interactive and project-based pedagogical technologies were proposed. At the ascertaining stage of the experiment, the level of students' learning was re-checked: high (learning coefficient from 1 to 0.7), medium (learning coefficient from 0.69 to 0.40), and initial (learning coefficient from 0.39 to 0.0).

The indicators of the levels of effectiveness of the educational impact of blended learning with elements of innovative pedagogy for the experimental and control groups were compared (according to Student's t-test), and the effectiveness of the proposed approach was established.

The main conclusions of the study were formed through generalisation.

In the future, it would be useful to extend the duration of the experiment and apply a mixed approach that includes qualitative indicators to provide a more complete picture of the impact of blended learning.

Results and Discussion

Blended learning is based on individualisation of the educational process, innovative development and



variability of forms of educational content combined within online and offline processes. At the same time, the traditional requirements for structured, systematic and educationally valuable learning material remain relevant. The specificity of blended learning is the priority of personalisation of education with the simultaneous development of group forms of work, including online. Among the priority advantages are the flexibility of class schedules, the adaptability of curricula, and the possibility of mastering a full module of educational material in informal education.

It is worth noting that the combination of synchronous and asynchronous modes in blended learning requires the development of specific methodological support. During the time allocated for offline classes, complex aspects of the learning material are discussed, or basic skills are practised. At the same time, the online format expands knowledge and skills on key provisions by using online educational platforms, mobile applications, and virtual conferences. At the same time, unhindered feedback from the teacher is provided. Integrating the interactive panel method makes it possible to organise training in which all participants receive the same information but choose their own time to master the training content. At the same time, students can view the interactive material an unlimited number of times.

The blended learning methodology is a reasonably new, adaptive structure that requires an appropriate approach to assessment. The latter should combine individual markers with the results of team projects and group work, and the assessment process can be implemented both by the teacher and using online tools.

During the study, a pedagogical experiment was conducted with 64 students of Lutsk National Technical University in Ukraine. The control group (with a traditional curriculum) consisted of 31 people, while the experimental group (with the proposed elements of blended learning technology) included 33 students. The experiment included diagnostic, formative, stating, and generalising stages (Table 1).

Table 1.
Structure of the pedagogical experiment

Experimental stage	Specifics of the stage
Diagnostic stage	Determination of the initial level of education of both groups of respondents
Formative stage	Integration of innovative elements of blended learning into the educational process of the experimental
The statement stage	Determination of the final level of training for both groups of respondents
Generalisation stage	Study of the dynamics of student performance and the effectiveness of the proposed technology

Source: compiled by the author

The initial level of learning of both groups of respondents was determined by identifying the average values of the learning coefficient (Table 2).

Table 2.
Initial learning rate for the experimental and control groups of students

Group	Specifics of the sample	The value of the learning curve
Control	Sufficient level of training and general competence	0,63
Experimental	Sufficient level of training and general competence	0,67

Source: compiled by the author

The diagnostic stage of the experiment showed that the levels of learning of the respondents of the experimental and control groups were comparable. At the same time, three levels were identified: high (learning coefficient from 1 to 0.7), medium (learning coefficient from 0.69 to 0.40) and initial (learning coefficient from 0.39 to 0.0) (Table 3).

Table 3.

The structure of the initial level of learning of students in the control and experimental groups

Group	High level, people	Average level, people	Baseline, people	Overall
Experimental	5	12	16	33
Control	4	13	14	31

Source: compiled by the author

As part of the formative stage, interactive forms of learning interaction, project-based learning tools, online platforms, the case method, and the problem-based learning method were proposed. In particular, the following methods were used:

- Embodied learning with elements of gamification, which increases students' interest and motivation and creates a comfortable atmosphere in the learning and communication environment;
- Targeted online learning platforms for students to master specific competences;
- An audiovisual method that involves visual non-verbal visualisation tools such as videos, podcasts and other content;
- Project methodology and case studies increase students' interest in learning outcomes;
- Problem-based learning, which develops skills in applying theoretical knowledge in real professional situations.

At the confirmatory stage of the experiment, it was found that there were noticeable changes in the groups of respondents. Thus, in the experimental group, the indicators of the learning coefficient increased by 17%, while in the control group - by 12% (Table 4). At the same time, the average level indicators in the experimental group increased by 25%, in the control group by 15%, and the high level indicators – by 60% and 25%, respectively (Table 5), which indicates the effectiveness of the applied blended learning methodology.

Table 4.

Establishment stage: learning rate for the experimental and control groups of students

Group	Specifics of the sample	The value of the learning curve
Control	Sufficient level of training and general competence	0,71
Experimental	Sufficient level of training and general competence	0,78

Source: compiled by the author

Table 5.

Establishing stage: structure of the level of learning of students in the control and experimental groups

Group	High level, people	Average level, people	Baseline, people	Overall
Experimental	8		10	33
Control		15	11	31

Source: compiled by the author

Table 6 presents the results of the comparison of the performance indicators of the experimental and control groups (by Student's t-test). The result of the calculation by Student's t-test is 19.5. Since the empirical value of t (19.5) is within the zone of significance, we can assert the effectiveness of the proposed technology.

Table 6.

Indicators of the levels of learning outcomes in the traditional and blended learning system for the experimental and control groups (according to Student's t-test)

№	Samples		Deviation from the mean		Deviation squares	
	B.1	B.2	B.1	B.2	B.1	B.2
1	61.3	81.5	-0.35	0.42	0.17	1.63
2	61.8	81.2	0.15	0.12	0.14	0.23
3	60.4	77.5	-1.25	-3.58	1.74	11.69
4	61.2	79.8	-0.45	-1.28	0.17	3.68
5	63.7	83.7	2.05	2.62	2.82	4.75
6	61.5	82.8	-0.15	1.72	0.006	1.90
Amounts:	369.9	486.5			5.04	23.88
Average:	61.65	81.08				

Source: compiled by the author

The generalising stage of the experiment allowed us to assess the effectiveness of the blended learning elements, indicating the feasibility of further research in this area. It is worth noting that the implementation of the blended learning concept requires compliance with several conditions:

- Practice-oriented strategic orientation by the requirements of future professional activities (coaching, discussion, and business games are relevant);
- Ensuring a high level of motivation of participants in the educational process;
- Selection of tools and techniques according to age group and professional area;
- Development of universal soft and digital skills necessary to ensure the competitiveness of future specialists.

Obviously, blended learning enables both students and teachers to realise themselves in a positive psychological microclimate, to actively interact and communicate, and to contribute to the efficiency of the educational process.

Modern researchers (Fan, 2022; Kilag et al., 2023) position blended learning as a purposeful process of acquiring knowledge, skills and abilities based on the synergistic use of traditional and innovative pedagogical technologies on mutual complementarity. Scholars emphasise that the blended learning methodology transforms the role of the teacher. Some researchers (Kumar, 2021) note the effectiveness of blended learning in the context of opportunities for ongoing dialogue, joint learning activities, and preserving the individual orientation of the educational process.

According to Sofi-Karim et al. (2023), the success of students' learning activities is determined by the level of implementation of interactive teaching methods and digital tools. At the same time, this requires the readiness of participants in the educational process to innovate and their motivation.

According to McKenna et al. (2020), the effectiveness of the blended learning process is determined by learning habits (responsibility, adaptability, perseverance), comfort of the learning environment, time management skills, methodology and motivation. In continuation, Míguez-Álvarez et al. (2022) highlighted the benefits of blended learning, including the formation of a favourable psychological microclimate, normalisation of the workload, establishment of communication between students and teachers, the ability to think critically and objectively, development of personal potential and the formation of a habit of continuous professional development.

Researchers Batista-Toledo & Gavilan (2022) identified factors influencing the educational process's effectiveness in digitalisation: openness to innovation, feedback and consultation, adaptability and readiness for limited conditions. At the same time, scientists argue that the modern educational field should

concentrate its potential on the formats of interactive content, portal technologies, and immersive environments that best meet the needs of the modern young generation.

The authors of Popa et al. (2020) update the methodology of interactive video lectures - educational content that ensures effective interaction between participants in the educational process and includes interactive elements (tests, links, additional materials). The advantage of interactive video lectures is the ability to adapt to the pace of learning and the personal needs of each student, which also includes the independent choice of the order of studying the material, instant feedback, and identification and correction of their mistakes.

At the same time, Abbacan-Tuguic (2021) believes that virtual laboratories allow students to work with equipment seamlessly in an online environment from anywhere and at any time. The ability to create different scenarios and levels of difficulty allows students to practice developing sustainable competence skills.

Monk et al. (2020) consider educational platforms and mobile learning applications that provide access to educational content and interactive tasks promising. Chatbots, online conferences, and project discussion forums allow for real-time experience exchange, helping improve communication competences. Online tests and surveys with automatic processing of results are an additional tool for checking the effectiveness of learning (Monk et al., 2020).

The potential of online platforms, including Microsoft Teams, Zoom, and Google Meet, facilitates real-time communication and distance learning across geographical distances. Mae et al. (2023) are convinced of this. The researchers attribute particular importance to video hosting sites, particularly YouTube, which have become a popular means of posting educational content. Furthermore, they consider it necessary to create online communities where students can share their experiences.

Contemporary scholars Ansari et al. (2023) are convinced that the traditional management paradigm in education in developing countries or countries that have experienced crises does not allow educational institutions to fully integrate into the globalized educational environment. According to the scientists, the dynamics of optimization transformations remain insignificant, and most reforms are eventually assessed as ineffective. At the same time, as Bizami et al. (2023), socio-political transformations, despite the whole range of destructive factors, are simultaneously a driving force for fundamental changes in the format of relations between educational institutions in the practice of organizing the educational process, as well as in terms of cooperation with other institutions to ensure the sustainable development of the educational environment. The concept proposed by the authors covers several innovative tools, including online platforms, incentive practices, and problem-based learning.

Windasari et al. (2024) see the issue of activating cooperation between educational institutions and the public as promising for priority resolution in the post-crisis period of regeneration. It should be noted that such experience is already commonplace in European countries. According to Cao (2023), the use of opportunities for interaction and cooperation with the global community by educational institutions has mutually beneficial features aimed at comprehensively addressing management issues in the field of education. The scholar emphasizes that interactive forms of interaction with learning, project-based learning, and online platforms, which are actively used in blended learning, significantly influence student success and the achievement of learning objectives.

In turn, according to Halverson et al. (2023), the tasks include establishing a system of structural and logical links between theoretical knowledge and its practical application, and implementing the principles of academic adaptability. The researchers' works highlight related challenges, including the need to ensure the relevance and appropriateness of teaching methods for a specific target audience, a high level of motivation among participants in the process, and a readiness for innovative solutions.

The above-mentioned blended learning tools can effectively provide access to education in remote areas,



helping to reduce spatial and temporal barriers. At the same time, the practical application of these methods requires the development of appropriate methodological support and integration into traditional educational strategies.

Positive results will potentially be facilitated by ensuring a favorable psychological microclimate during the experiment, as well as minimizing the impact of experimental constraints (duration, context, sample size).

Conclusions

The proposed concept of blended learning in higher education encompasses several innovative tools, including online educational platforms and mobile applications, interactive content, individualisation of the learning process, problem-based learning, project-based learning, and case studies. At the same time, there is a need to ensure the relevance and appropriateness of pedagogical techniques for a particular target audience, a high level of motivation of the participants in the process and readiness for innovative solutions.

After implementing the proposed elements in the educational process at the control stage of the pedagogical experiment, it was found that the indicators of the learning coefficient increased by 17%, while in the control group – by 12%. At the same time, the indicators of the middle level in the experimental group increased by 25%, in the control group by 15%, and the high level - increased by 60% and 25%, respectively, which indicates the effectiveness of the applied methodology of blended learning in the experimental group. Since the empirical value of the Student's t-test is 19.5 and is within the zone of significance, we can assert the effectiveness of the proposed technology.

It is obvious that effective implementation of blended learning technologies in the higher education environment can improve not only students' social and communication competence and digital skills but also the overall level of learning effectiveness of the process. However, the aspects of inclusiveness in blended learning require further development.

The study has certain limitations, such as a small sample size and short duration of the experiment. Prospects for expanding scientific research on the subject under study are seen in the formation of practical strategies for integrating the blended learning model into the realities of the educational environment with subsequent testing in various educational institutions. It is also promising to study the effects of long-term hybrid learning or its impact on variables such as motivation, autonomy, and interaction.

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