



Revista de Tecnología de
Información y Comunicación en Educación

Online ISSN: 2665-0223

Print ISSN: 1856-7576



Volumen 19, No. 2.
Abril - Junio 2025

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Facultad de Ciencias de la Educación



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Depósito legal: pp200702CA2520

ISSN: 1856-7576

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Código Revencyt: RVE022

Registrada en el Catálogo Latindex con el número de folio 19424

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La revista Eduweb es una publicación trimestral editada por la Universidad de Carabobo. Es una publicación de ámbito nacional e internacional indizada en el índice de Revistas Venezolanas de Ciencia y Tecnología REVENCYT, en el Catálogo LATINDEX, Actualidad Iberoamericana, Dialnet, Red Iberoamericana de Innovación y Conocimiento Científico REDIB, y en Emerging Sources Citation Index.



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Versión electrónica de la Revista:

<http://revistaeduweb.org>

Esta edición se produce bajo el auspicio del Consejo de Desarrollo Científico y Humanístico y la Dirección de Postgrado de la Facultad de Ciencias de la Educación de la Universidad de Carabobo.

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Eduweb, la revista de Tecnología de Información y Comunicación en Educación, es una publicación de carácter nacional e internacional de divulgación del conocimiento, del uso, aplicación y experiencias de las Tecnologías de la Información y Comunicación (TIC) en ambientes educativos. Con la revista se pretende divulgar las innovaciones que en materia de TIC están siendo implementadas y ensayadas en los diferentes niveles y modalidades del sistema educativo venezolano e iberoamericano. De igual manera contribuir a proyectar las experiencias de estudiantes de pre y postgrado, docentes, investigadores y especialistas en TIC en educación en la Universidad de Carabobo y en otras universidades de Venezuela y de otros países de Iberoamérica. Es una revista arbitrada e indexada adscrita al programa de la especialización en Tecnología de la Computación en Educación, de la Facultad de Ciencias de la Educación de la Universidad de Carabobo, registrada bajo el ISSN 1856-7576. Editada en formato impreso y digital.

Visión

Ser un espacio académico-científico de difusión y divulgación de las distintas tendencias del pensamiento universal ubicadas en el área de TIC en ambientes educativos, con altos niveles de calidad académica.

Misión

Promover y facilitar la difusión y divulgación de los productos de las investigaciones y experiencias de los docentes e investigadores de la Universidad de Carabobo y otras universidades del país y del mundo en el área de TIC en ambientes educativos; motivar la participación en redes comunes de información y publicación nacional e internacional; coordinar esfuerzos y velar por la calidad de las publicaciones a fin de procurar elevar el nivel académico del personal docente y de investigación mediante el desarrollo de trabajos de investigación como función esencial en su crecimiento académico.

Objetivos

Servir como órgano de divulgación de las TIC y su influencia en ambientes educativos. Estimular la producción intelectual no solo en los docentes e investigadores de la Universidad de Carabobo, sino también en otros centros de educación e investigación nacional e internacional.

Propiciar el intercambio cultural, académico, científico y tecnológico con otros centros de educación superior en Venezuela y el mundo.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.0>

Cómo citar:

Medina, E. (2025). Editorial. *Revista Eduweb*, 19(2), 7-8. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.0>

Editorial

Para publicar es necesario comunicar y este proceso comunicativo lleva intrínseco una arquitectura lingüística que indefectiblemente se basa en el uso del lenguaje escrito. Este poderoso trabajo de escritura conlleva no solamente el hecho de hilvanar palabras, oraciones y sintagmas completos, sino que lleva un contenido entrelazado en ideas que están en la mente de quien ha experimentado la investigación con la pasión de encontrar verdades que ayuden a comprender el agitado mundo que están viviendo tanto la generación emergente como las de mayor trayectoria. Nunca el aprendizaje había estado tan expuesto a la distracción y al “facilismo”, podría decirse algo cercano a la resistencia pasiva. Distracción porque las múltiples herramientas disponibles generan curiosidad por indagar cuál es la que mejor se adapta a la necesidad específica del usuario; mientras que el facilismo es sin duda la categoría emblemática de comodidad para escribir, ya que la herramienta ofrece no solamente reescribir o mejorar un contenido parcial de la escritura, es que ofrece además la generación de informes, reportes y proyectos sistematizados, según la instrucción que se la ha suministrado.

Sí, se trata del Prompt y de toda su ingeniería para indicar ante la herramienta qué queremos y cómo lo queremos. También, se trata de la intervención de la pragmática especialmente por el contexto, la intención comunicativa y claridad del lenguaje. Y, depende de cómo se delinea cada sentencia para conseguir la esperada respuesta, esto nos recuerda una de las experiencias básicas cuando iniciamos en el mundo de pensamiento de la filosofía que remite, siempre, al arte de la pregunta y su entrañable meta de conseguir respuestas, eso sin duda ha cambiado bruscamente, porque ahora el usuario pregunta a la herramienta y sin cuestionamiento alguno obtiene respuestas que cree veraces. Hemos, sin duda, reemplazado el arte de preguntar y cuestionar por el “facilismo” de respuestas elaboradas según el infinito número de data revisada y expuesta en tan solo minutos. Podríamos decir que, se trata de conocimiento almacenado, cuya antítesis es el conocimiento definido por Gastón Bachelard como producto de una actividad del sujeto que no consiste en una simple reproducción de las cosas. El sujeto es, en consecuencia, un constructor de conocimiento. Justo en esta teoría Bachelardiana se centra la preocupación expuesta sobre ¿Cómo retomar el proceso de enseñar a reflexionar, criticar, cuestionar, formular preguntas en un contexto de cambio y auge tecnológico? ¿Cómo reanudamos? el rol del usuario de las tecnologías para que forme parte activa de la experiencia de aprendizaje conducente a la construcción del conocimiento. Representa un reto y un desafío pedir transparencia en el uso de herramientas como apoyo y no como la solución absoluta, en este escenario surge el tema de la ética e integridad académica que, parece un tópico en ascenso que bien nos recuerda la ocupación de los grandes y antiguos pensadores cuando reflexionaban sobre qué es lo justo y en que consistía la relación entre individuo y sociedad, ubicándonos en la pregunta filosófica ¿Cómo debemos vivir?

Como medio de divulgación del conocimiento en la temática educación y tecnología, consideramos que este planteamiento es pertinente con la efervescencia que nos genera el uso de herramientas de la Inteligencia artificial y representa un corolario para ocupar nuestros pensamientos y pasión investigativa.

Nos sentimos complacidos de presentar los trabajos de investigación que conforman este número; por su parte tenemos el documento titulado “Utilización de técnicas de aprendizaje automático para predecir el rendimiento escolar en matemáticas” Los hallazgos destacan la relevancia de la identificación temprana de dificultades de aprendizaje para viabilizar intervenciones pedagógicas estratégicas”. Así también, presentamos “El impacto del asesoramiento educativo basado en IA en la eficacia de la enseñanza” cuyo objetivo estuvo centrado en revisar la eficiencia de los sistemas de asesoramiento educativo de Inteligencia Artificial con respecto a las prácticas de enseñanza y el papel de estas tecnologías. Podrán leer como número tres la investigación sobre “Ciberseguridad en la Educación Superior Ucraniana: Amenazas y medidas de protección” con el propósito de analizar el impacto de la ciberseguridad en la educación superior en Ucrania. Como número cuatro tenemos el documento “Evolución del concepto de derecho a la educación en la pedagogía general y su influencia en la política educativa de Ucrania” destacándose entre las conclusiones: la transición al sistema europeo de enseñanza secundaria, la introducción de programas integradores y el fortalecimiento de la educación superior. La lectura número cinco se titula “Análisis de métodos de enseñanza del inglés como lengua extranjera mediante tecnologías multimedia” Estos autores confirmaron que el uso de herramientas multimedia mejora



la competencia en lenguas extranjeras, fomenta el pensamiento creativo. En lectura número siete encontraremos. En un lugar número seis consultarán sobre el tema de "Educación 4.0: Desarrollo del sistema educativo ucraniano en el contexto de la inteligencia artificial" desde el objetivo de analizar el concepto de Educación 4.0 y sus principales logros, desafíos y perspectivas en el contexto del desarrollo de la inteligencia artificial en el sistema educativo de Ucrania. El artículo siete versa sobre "Mejorar la eficacia del aprendizaje mediante métodos de educación híbrida", sus resultados mostraron que el uso de técnicas de aprendizaje semipresencial contribuye a la acumulación efectiva de los alumnos. En un lugar ocho: "Aplicación de la práctica del CEDH en la educación jurídica: impacto en la formación de la cultura judicial y la protección de los derechos humanos" esta investigación analiza enfoques orientados a la práctica para la enseñanza de los estándares internacionales de derechos humanos. Le sigue el lugar número nueve "Desarrollo de la competencia creativa en estudiantes universitarios a través de las tecnologías de la información: un estudio experimental", como parte del resultado se formó una dinámica positiva de la competencia creativa debido al uso de tecnologías de la información modernas entre los estudiantes. Como número 10 el documento se titula "Uso de las tecnologías de la información en el aprendizaje de los estudiantes de postgrado", en el que el objetivo consistió en analizar el uso de TIC como herramienta de aprendizaje de los estudiantes de Postgrado de Obstetricia y Ginecología de la ciudad Hospitalaria Enrique Tejera. Por su parte, el trabajo número 11 "Modelos educativos para el desarrollo de la experiencia en aduanas, corretaje y aplicación de la ley en la cooperación transfronteriza entre la UE y Ucrania", la conclusión de sus autores la basaron en recomendaciones para avanzar en la educación aduanera mediante la colaboración internacional, el uso de tecnologías educativas. En una lectura número doce: "El uso de las tecnologías educativas para garantizar la continuidad de la educación preescolar y primaria" La investigación empleó los siguientes métodos: cuestionarios, pruebas y aplicación experimental de plataformas interactivas en instituciones educativas. Un documento número trece "Enfoques modernos para resolver conflictos intergeneracionales en la educación: innovaciones y recomendaciones prácticas" su propósito fue identificar los enfoques modernos de este conflicto de generaciones y formular recomendaciones para resolver los malentendidos en el sistema de enseñanza superior. Como número catorce "Desarrollo de la competencia de consultoría en el espacio educativo digital: un estudio experimental en la educación superior" en el que sus autores demuestran la eficacia de las tecnologías de la información en las actividades de consultoría. Adicionalmente, la lectura quince "Aplicación de métodos para desarrollar la audición musical y el ritmo en estudiantes no musicales de centros de enseñanza superior" por su parte el objetivo fue sobre la aplicación de métodos para desarrollar la audición musical y el ritmo en estudiantes no musicales de centros de enseñanza superior. Un trabajo que ocupa el número dieciséis se titula "La eficacia de los sistemas de proyección/tableros multimedia en la enseñanza de las humanidades" su propósito estuvo basado en evaluar la eficacia del uso de pizarras multimedia (PTM) para desarrollar las competencias profesionales de los estudiantes de humanidades. La investigación número diecisiete "Análisis documental de la política educativa de Ucrania en el contexto del conflicto: el caso de la prohibición de formar abogados en los organismos encargados de hacer cumplir la ley", este artículo ofrece un panorama documental de los principales cambios regulatorios e institucionales que han caracterizado la política de educación superior en Ucrania en los últimos años. Conforme este número también el trabajo dieciocho "Clasificación de innovaciones y desafíos en la enseñanza de la educación física en la era digital", el propósito del artículo fue realizar un análisis sistemático de nuevas soluciones innovadoras y problemas clave de su implementación en el proceso de enseñanza de la educación física. La investigación diecinueve titulada "La importancia de la inteligencia artificial en el fomento de las competencias profesionales del futuro: una revisión sistemática", centraron el objetivo en realizar una revisión sistemática de materiales relevantes publicados entre 2018 y 2025. Finalmente, se cierra el número con la investigación titulada "Aspectos motivacionales del acoso a niños con necesidades especiales en el proceso educativo", en la que se reveló que la victimización se asocia frecuentemente con la limitada capacidad de autodefensa y los retos de integración social a los que se enfrentan los alumnos con necesidades especiales.

Los invitamos a profundizar en cada uno de los temas expuestos y que pretenden mantener la publicación sobre el tema de tecnología en estos momentos de intensidad por el uso de herramientas de inteligencia artificial.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.1>

Cómo citar:

Batista da Silva, J., Assis da Costa, L.C., dos Santos, J.N., & Oliveira da Silva Batista, R. (2025). Using machine learning techniques to predict academic performance in mathematics. *Revista Eduweb*, 19(2), 9-19. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.1>

Using machine learning techniques to predict academic performance in mathematics

Utilización de técnicas de aprendizaje automático para predecir el rendimiento escolar en matemáticas

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Recibido: 24/04/25

Aceptado: 19/05/25

Abstract

The purpose of this study was to investigate the predictive power of the SAEF exams in estimating the schools' performance in Mathematics on the SPAECE exam. To achieve this, we developed a predictive machine learning model. The model was trained using data from 133 schools that participated in the exams in 2022, and subsequently tested with data from 140 schools that took part in the exams in 2023. The results showed that the random forest (RF) model demonstrated moderate predictive power ($R^2 = 0.397$), which was superior to the linear model ($R^2 = 0.384$). This means that approximately 39.7% of the variance in schools' Mathematics performance on the SPAECE can be explained by the results of the SAEF exams. The first SAEF exam, administered at the beginning of the academic year, demonstrated the highest predictive power among the three, indicating that students' initial performance in Mathematics is a strong indicator of their future performance. These findings underscore the importance of early identification of learning difficulties to enable strategic pedagogical interventions throughout the year. Although this study was conducted within the Brazilian educational context, other countries can also utilize machine learning techniques to monitor students' academic trajectories and predict their outcomes in standardized assessments.

Keywords: artificial intelligence, assessment, large-scale, machine learning, random forest.



Resumen

El propósito de este estudio fue investigar el poder predictivo de los exámenes del SAEF para estimar el desempeño en Matemáticas de las escuelas en el examen del SPAECE. Para ello, desarrollamos un modelo predictivo de Machine Learning. El modelo fue entrenado con datos de 133 escuelas que participaron en los exámenes en 2022 y posteriormente probado con datos de 140 escuelas que participaron en los exámenes en 2023. Los resultados mostraron que el modelo Random Forest (RF) presentó una capacidad predictiva moderada ($R^2 = 0.397$), superior al modelo lineal ($R^2 = 0.384$). Esto significa que aproximadamente el 39.7% de la variación en el desempeño de las escuelas en Matemáticas en el SPAECE puede ser explicada por los resultados de los exámenes del SAEF. El primer examen del SAEF, aplicado al inicio del año lectivo, presentó el mayor poder predictivo entre los tres, indicando que el desempeño inicial de los estudiantes en Matemáticas es un fuerte indicador de su desempeño futuro. Estos hallazgos destacan la relevancia de la identificación temprana de dificultades de aprendizaje para viabilizar intervenciones pedagógicas estratégicas a lo largo del año. Aunque este estudio fue realizado en el contexto educativo brasileño, otros países también pueden utilizar técnicas de Machine Learning para monitorear la trayectoria académica de los estudiantes y predecir sus resultados en evaluaciones estandarizadas.

Palabras clave: Inteligencia artificial, Evaluación, Gran escala, machine learning, random forest.

Introduction

Brazil's integration into the global economy has reinforced the implementation of educational policies by incorporating management models derived from a conception of an evaluative state that gradually strengthened and broadened the scope of large-scale assessments in the country, leading Brazilian states to follow suit (Afonso, 2009; Ball, 1998; Barroso, 2003; Gentili & Silva, 2015; Lessard & Carpentier, 2016; Costa et al., 2019).

Brazilian states implement standardized tests to monitor student performance and promote pedagogical interventions aimed at improving educational indicators. The state of Ceará is a pioneering example in the implementation of specific evaluations using the Ceará Permanent System for the Evaluation of Basic Education (Sistema Permanente de Avaliação da Educação Básica do Ceará – SPAECE, in Portuguese). In Brazil, basic education refers to the entire spectrum of primary and secondary education, from kindergarten to high school (Vidal et al., 2024).

The government of Ceará created SPAECE in 1992 to adapt national guidelines to local specificities and assess student competencies (Lima et al., 2021). The Ceará Department of Education annually administers the standardized SPAECE exam in public schools, focusing on reading and mathematics skills.

In the city of Fortaleza, the capital of Ceará, the Municipal Department of Education (SME) developed the Elementary Education Assessment System (Sistema de Avaliação do Ensino Fundamental – SAEF) to monitor the performance of students in municipal public schools and prepare them for SPAECE (Mendes et al., 2023). The SME administers the SAEF tests three times a year to students in elementary school (1st–5th grade) and middle school (6th–8th grade).

SAEF data enable the performance diagnosis of students for administrators and teachers (Lopes et al., 2017). Moreover, it facilitates the implementation of pedagogical interventions not only to enhance learning but also to prepare and train students for state assessments, such as the SPAECE exam (Oliveira et al., 2021; Vidal & Costa, 2021). Educational administrators refer to this approach as performance management (Camarão et al., 2015).

The Ceará government has been strengthening the performance management policy as a strategic approach in public education, based on the logic of accountability (Costa & Vidal, 2020). This approach

aims to hold schools accountable for their results, encouraging them to meet clear and measurable performance targets. In this context, the state government has implemented school bonuses tied to the results of large-scale assessments to stimulate improvements in performance indices, based on the scores that students achieve on the SPAECE.

Considering that one of the main purposes of the SAEF is to prepare students to take the large-scale SPAECE examination (Oliveira et al., 2021; Holanda, 2024), the following research question arises: What is the predictive power of the SAEF exams in estimating students' performance on the SPAECE?

In this context, the purpose of this study was to investigate the predictive power of the SAEF exams in estimating schools' Mathematics performance on the SPAECE examination. To achieve this, we applied machine learning techniques (random forest) to identify statistical correlations between the exam results and the performance on the SPAECE.

This study formulated two research hypotheses. Hypothesis 1 is that students' results in the SAEF have predictive power to estimate school performance in the SPAECE exam, particularly in Mathematics. Hypothesis 2 proposes that the random forest machine learning model has greater predictive capability for student performance in SPAECE compared to traditional statistical models, such as linear regression.

Random Forest: concepts, construction, and applications in machine learning

Random Forest (RF) is a supervised machine learning (ML) algorithm widely used for classification and regression tasks, notable for its effectiveness and versatility across various applications. In ML, a supervised algorithm is one that learns from labeled data, where each example in the dataset has an associated input and output.

The RF analysis method is a non-parametric technique aimed at improving the predictive performance of models (Breiman, 2001). This algorithm is extensively utilized in the field of Data Science, combining multiple decision trees to achieve results of high precision and stability (Queiroga et al., 2022).

The RF model is built through the combination of decision tree predictors, with each tree using a different bootstrap sample of the data, and successive trees not depending on previous ones (Liaw & Wiener, 2002). The statistical technique called bootstrap creates several data samples from the original sample of the same size, allowing some data to repeat while others may not be present in a given sample (Figure 1). This introduces variation among the samples, which can be beneficial for the robustness of the model.

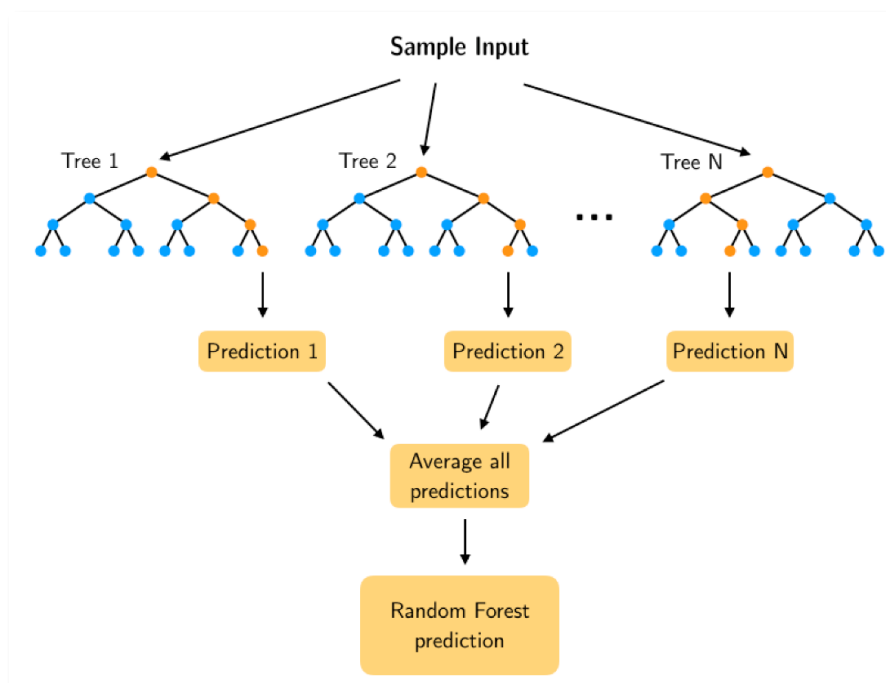


Figure 1. Schematic diagram of random forest model (Yang et al., 2022)

The training of each tree takes place on a random subset of the training data. The splitting of data at each tree node is conducted using a random subset of features (Queiroga et al., 2022). This introduces randomness and diversity into the learning process, making the trees less prone to overfitting. Overfitting is an excessive tailoring to the training data in more complex models (Dewi & Chen, 2019), which results in excellent performance on the training set but likely leads to poorer performance on test data (Probst et al., 2019).

After the trees are trained, the RF algorithm produces the final prediction by computing the average of the predictions from the individual trees that make up the forest (Dewi & Chen, 2019). The principle of the random forest algorithm can be expressed as follows:

$$Y = \frac{1}{N} \sum_{t=1}^n F_t(X)$$

where X is the input feature vector, Y is the prediction result, and N is the number of regression tree models built (Yang et al., 2022).

One of the advantages of RF is its ability to handle multicollinearity by accommodating highly correlated variables without introducing bias (Liaw & Wiener, 2002). Additionally, RF excels in feature selection, allowing for the assessment of the relative importance of each variable, thereby assisting in the selection of the most relevant features.

Methodology

Participants

This study analyzes information on the mathematics performance of 18,389 students from 133 municipal

public schools in Fortaleza, in the state of Ceará, Brazil. The performance of each school is determined by the average scores of eighth-grade students on the standardized SPAECE mathematics exams. The students' average ages range from 14 to 15 years.

Data collection

This study utilized data from two official government sources: SAEF (SME, n.d.) and SPAECE (SEDUC, n.d.). The dataset covers the period from 2022 to 2023. The SAEF administers three mathematics exams throughout the year: the first (Saef_1) at the beginning of the academic year in February, the second (Saef_2) in June, and the third (Saef_3) in October. Each exam contains 26 mathematics items. The detailed analysis of student performance is conducted by the Learning Assessment Cell (Célula de Avaliação da Aprendizagem - CEAVA), a division of the Municipal Education Secretariat (Secretaria Municipal de Educação - SME) of Fortaleza, which plays a crucial role in planning, developing, coordinating, and monitoring the SAEF. Furthermore, CEAVA collects and analyzes data on student learning, providing valuable information for the development of public educational policies (Fortaleza, 2019).

In November, SPAECE conducts a large-scale assessment consisting of an exam with 26 mathematics items. The Center for Public Policies and Evaluation of Education (Centro de Políticas Públicas e Avaliação da Educação - CAEd, in Portuguese) is responsible for designing and administering the SPAECE exam. CAEd is an institution affiliated with the Federal University of Juiz de Fora (UFJF), specializing in educational assessment. Its goal is to support public managers and educational institutions in the formulation, implementation, and monitoring of educational policies, based on data collected through large-scale assessments and other methodologies.

Estimation of Model

To achieve the purpose of this research, we developed a predictive model using advanced machine learning techniques (Edwards et al., 2021), with an emphasis on the random forest algorithm. We chose this algorithm for its robust ability to handle complex data and its functionalities in prediction processes involving multiple variables. The application of the model aimed to clarify the impact of SAEF on school performance in SPAECE.

In constructing the predictive model, we selected three explanatory variables, named Saef_1, Saef_2, and Saef_3. These variables correspond to the schools' performance in the SAEF mathematics exam throughout the academic year. Additionally, we used a response variable, named Spaece_Mathematics, which represents the schools' performance in the SPAECE mathematics exam. Table 1 provides a detailed description of each variable.

Table 1.
Description of the predictor variables

Code	Variables	Type	Description	Month of Application	Developers	Level
Saef_1	Explanatory	Continuous	Performance in the first SAEF Mathematics exam	February	CEAVA/SME	District level
Saef_2	Explanatory	Continuous	Performance in the second SAEF Mathematics exam	June	CEAVA/SME	District level
Saef_3	Explanatory	Continuous	Performance in the third SAEF Mathematics exam	October	CEAVA/SME	District level
Spaece_Mathematics	Response	Continuous	Performance in the SPAECE Mathematics exam	November	CAEd	State Level

Based on the Hold-out method (Kumar, 2022), we trained the model using performance data from 133 schools that participated in the mathematics exams in 2022. After training, we tested the model with data from 140 schools that participated in the exams in 2023.

We analyzed the data using the random forest regression technique, a robust machine learning method based on decision trees. This approach allows for capturing complex relationships between explanatory variables (Saef_1, Saef_2, and Saef_3) and the response variable (Spaece_Mathematics). Additionally, the RF analysis method efficiently handles nonlinear and multivariate data. The generated model identifies patterns in the data and evaluates the relative contribution of each explanatory variable in predicting the final performance in the SPAECE exam.

Additionally, we examined variable importance and the distribution of minimum depth through tree modeling to identify which are most influential in predicting the outcome (Spaece_Mathematics). We conducted the RF model estimation using RStudio software and the 'randomForest' and 'randomForestExplainer' packages.

Data analysis

We conducted an evaluation of the RF model's performance using three specific metrics: Mean Absolute Error (MAE), Mean Squared Error (MSE), and the Coefficient of Determination (R^2). These metrics provide crucial insights into the accuracy and generalization capability of the developed model.

The MAE quantifies the average absolute differences between the predicted and observed values, serving as an intuitive measure of the model's accuracy. Since it does not account for the direction of errors (positive or negative), a lower value indicates greater accuracy in predictions.

The MSE, in turn, measures the discrepancy between the predicted and actual values by averaging the squares of the prediction errors. The lower the MSE, the more precise the model's predictions; higher values of this metric indicate a larger error in estimating the outcomes (Yang et al., 2018).

Meanwhile, the Coefficient of Determination (R^2) expresses the proportion of variability in the dependent variable that is explained by the model. Its value ranges between 0 and 1, with values closer to 1 indicating a higher explanatory power of the model, while values nearing 0 suggest low adherence to the observed data (Hair et al., 2009).

By applying these metrics together, we comprehensively evaluated the model's performance, ensuring its accuracy and reliability in analyzing the factors that influence academic performance in mathematics. Furthermore, we used these metrics to fine-tune the model, fostering a continuous process of validation and refinement of the results.

Results and Discussion

This research aimed to investigate the predictive power of the SAEF examinations for estimating students' performance in Mathematics on the large-scale standardized SPAECE exam. To achieve this, we developed a predictive model using the random forest algorithm.

The results indicated that the random forest model (Model_rf) exhibited moderate predictive ability ($R^2 = 0.397$), suggesting that approximately 40% of the variance in schools' mathematics performance on SPAECE can be explained by the variables included in the model. Furthermore, the performance of the random forest-based model (Model_rf) was slightly superior to that of the Multiple Linear Regression model (Model_lm) across all the metrics analyzed. Table 2 presents the performance metrics of these models, which we evaluated using the test data.

Table 2.
Comparison of model performance metrics with test data

	Testing		
	R^2	MAE	MSE
Model_rf	0.397	10.582	186.924
Model_lm	0.384	11.928	277.345

In terms of Mean Absolute Error (MAE), the Model_rf showed a lower value (10.582) compared to Model_lm (11.928), demonstrating greater prediction accuracy. The analysis of the Mean Squared Error (MSE) also revealed an advantage of Model_rf, with a value of 186.924 compared to 277.345 for Model_lm, suggesting that the predictions of the RF-based model were more consistent. Figure 2 displays the relative importance ranking of the explanatory variables (Saef_1, Saef_2, Saef_3), according to the Percentage Increase in Mean Squared Error (%IncMSE) and the Increase in Node Purity (IncNodePurity). These results confirm Hypothesis 2.

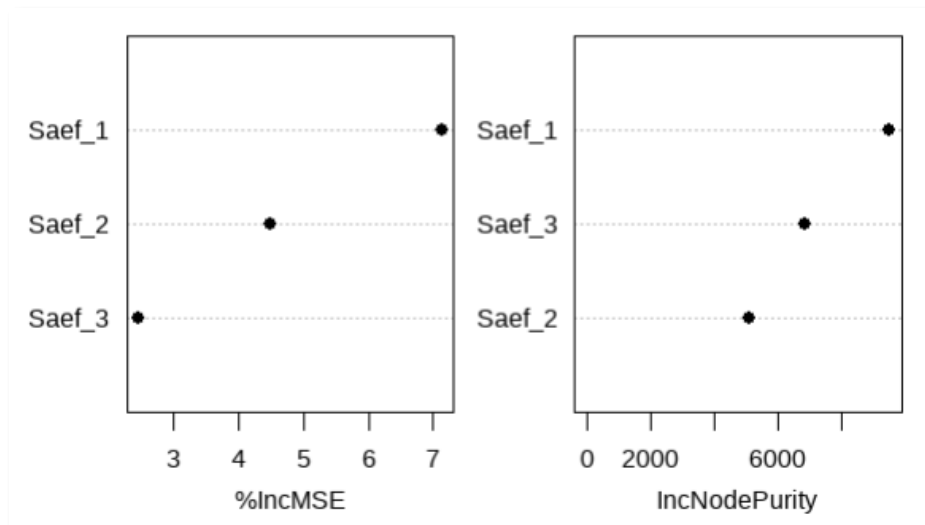


Figure 2. Relative importance of variables in the random forest model.

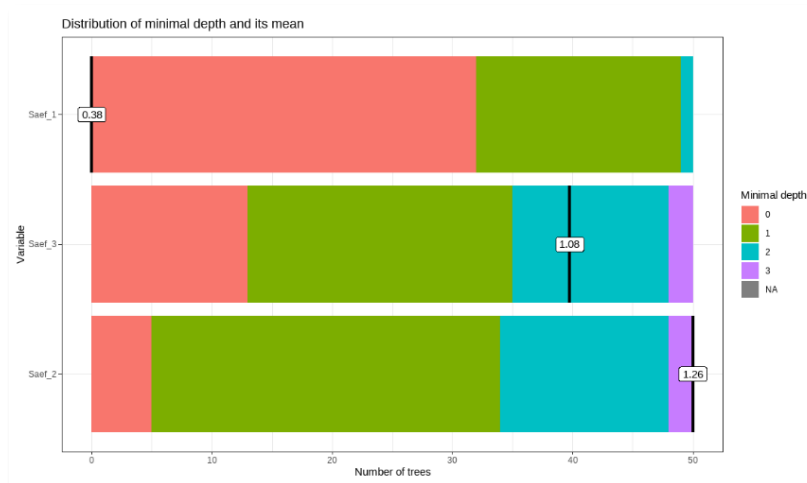


Figure 3. Distribution of minimal depth for variables according to the average minimum depth calculated.

The first exam (Saef_1), administered at the beginning of the academic year, represents the most significant variable in the predictive model. This exam ranks first in terms of the percentage increase in average mean squared error (%IncMSE) (Figure 2) as well as in node impurity reduction in the tree (IncNodePurity). Furthermore, the Saef_1 variable exhibits a low minimum depth in the tree (Figure 3), underscoring its high importance to the model. This is justified by the significant impact of removing this variable, which results in a substantial increase in mean squared error (MSE). Thus, the analysis reinforces the central role of Saef_1 in predicting student performance. These results support Hypothesis 1.

Variables with the highest %IncMSE values have the greatest influence on the predictive model. However, it is essential to emphasize that %IncMSE is a relative measure, as the importance of a variable is determined in relation to the others present in the model (Liaw & Wiener, 2002). Consequently, including or removing a variable can directly impact the %IncMSE values of others, altering their importance hierarchy within the model.

The results of this study evidence that the first SAEF exam possesses a high predictive power for students' final performance in SPAECE. This finding suggests that data collected at the beginning of the school year play a crucial role in anticipating academic performance throughout the academic period, reinforcing the relevance of diagnostic assessments in the early identification of difficulties and the planning of pedagogical interventions.

The results indicate that the initial exam plays a fundamental role in measuring the prior knowledge students bring at the start of the academic year, thereby exerting a significant influence on their academic performance throughout the school period. As argued by Lima et al. (2021), upon entering school, students already possess empirical knowledge that needs to be restructured for the construction and consolidation of new learning.

In this context, students' initial performance emerges as a key indicator for predicting academic progress, enabling the early identification of learning gaps and guiding the implementation of more effective pedagogical interventions. Therefore, this investigation underscores the importance of the first exam not merely as a diagnostic instrument but also as a strategic tool for educational planning. By offering an overview of students' knowledge level, this assessment allows educators to develop teaching plans that are more aligned with the specific needs of each group, contributing to the reduction of learning gaps and the optimization of students' performance in external assessments, such as SPAECE.

The findings of this research are consistent with the existing literature, particularly with the contributions of Ausubel et al. (1968), which emphasize the importance of subsumers – prior concepts stored in the cognitive structure – as fundamental elements for meaningful learning. More recent studies support this theory (Lopes et al., 2017; Silva, 2020; Queiroga et al., 2022), reinforcing the direct relationship between the student's initial knowledge and its implications for subsequent learning processes.

Lopes et al. (2017) highlight that when diagnostic assessments are conducted in alignment with the student's level of knowledge, they not only provide crucial information for the teacher's pedagogical support in daily practice but also allow for more accurate predictions of student outcomes in external evaluations, such as SPAECE. This predictive capability underscores the relevance of diagnostic assessment as a tool not only for diagnosing learning gaps but also as a strategic instrument for improving academic performance in large-scale assessments.

Queiroga et al. (2022) highlight that students' prior academic performance in Uruguay is one of the main predictors of their future performance, underscoring the importance of considering the knowledge base already acquired by students throughout their educational journey. This perspective is widely supported by David Ausubel's Theory of Meaningful Learning, which emphasizes the crucial role of prior knowledge in the learning process, considering it one of the most determining factors in students' cognitive development (Silva, 2020).

According to Ausubel et al. (1968), among the various variables influencing learning, prior knowledge holds a central position and serves as a foundation for building new understandings. In this context, it is imperative that the starting point of the educational process takes into account what the student already knows, as this pre-existing knowledge facilitates the assimilation of new content. In line with this theory, the results of this study highlight the importance of using initial assessments as strategic tools to guide pedagogical decisions and plan instruction (Lima et al., 2021). By effectively exploring these initial assessments, it is possible to enhance student learning throughout the academic year, promoting more effective development aligned with their cognitive and educational needs.

Despite the significance of the study's findings, we acknowledge that it presents certain limitations that must be considered. First, the model explains approximately 40% of the variance in SPAECE scores, suggesting that other unmeasured factors also influence student outcomes. These factors may include socioeconomic status, teacher quality, school resources, student motivation, among others. Secondly, the study focuses exclusively on schools in Fortaleza, Ceará, Brazil. This regional focus restricts the generalizability of the results to other contexts, particularly those with different educational systems or demographic characteristics.

Conclusions

The purpose of this study was to investigate the predictive power of the SAEF exams in estimating Mathematics performance of public schools in the municipality of Fortaleza on the large-scale SPAECE exam. To this end, we employed a predictive model based on regression with the application of machine learning techniques, specifically using the random forest (RF) algorithm.

The results indicated that the RF model exhibited a moderate predictive capability ($R^2 = 0.397$), suggesting that approximately 39.7% of the variance in Mathematics performance on the SPAECE can be explained by the SAEF exams. The study's findings demonstrate the potential of SAEF as a diagnostic assessment tool. We identified that the first SAEF exam has the greatest predictive power for SPAECE performance, which suggests the importance of early pedagogical interventions, right at the beginning of the academic year.

However, it is important to highlight that the predictive capability is not absolute, indicating that there are other factors not captured by the model that also influence student performance. Furthermore, diagnostic assessment is merely a complementary tool, constructed from a formative perspective, aimed at indicating proficiency levels in Mathematics (Lima et al., 2021).

In this regard, for the diagnostic purpose of the SAEF to be fully effective, it is crucial that the results are interpreted with caution, avoiding inappropriate uses, such as the mere classification or ranking of schools. Additionally, continuous support for administrators and teachers is essential to use the data strategically in educational planning.

Based on the results obtained, we conclude that SAEF mathematics exams have significant potential to predict performance in large-scale assessments, especially when applied alongside algorithms that exploit the data structure more effectively, such as the random forest. This type of approach allows for greater precision in anticipating results, grounding strategic decisions in concrete data, which is essential for supporting decision-making in educational policy development.

SPAECE exemplifies a widely adopted practice of large-scale assessment used in various countries to monitor the quality of education and guide public policy formulation. In this context, the predictive capability of diagnostic exams, as demonstrated by the SAEF study, plays a fundamental role in supporting informed decision-making by educational managers.

Although this study is situated within the Brazilian educational context, the concern with school performance in large-scale assessments is a global issue. The research conducted in the municipality of Fortaleza, Ceará, demonstrates that the administration of periodic exams throughout the school year can significantly



contribute to predicting student performance in large-scale assessments. This finding suggests that educational systems utilizing regular diagnostic assessments may adopt similar approaches to monitor and anticipate students' academic performance.

The incorporation of machine learning techniques in the analysis of educational data, such as the regression used in this study, reflects an international trend in the field of education. These techniques enable the identification of complex patterns and enhance the accuracy of predictions, aiding in the early detection of at-risk students and facilitating the implementation of more effective pedagogical interventions.

Countries that adopt periodic exams can benefit from the application of predictive models based on machine learning to estimate student performance in standardized assessments. The increasing use of these methodologies underscores their potential in education. Ultimately, this study contributes to the field by demonstrating the feasibility and applicability of predictive models in the analysis and management of academic performance.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.2>

Alenezi, A., & Alenezi, A. (2025). The impact of AI-Based educational counseling on teaching effectiveness. *Revista Eduweb*, 19(2), 20-37.
<https://doi.org/10.46502/issn.1856-7576/2025.19.02.2>

Cómo citar:

The impact of AI-Based educational counseling on teaching effectiveness

El impacto del asesoramiento educativo basado en IA en la eficacia de la enseñanza

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Recibido: 27/03/25

Aceptado: 07/05/25

Abstract

This paper aims to review the efficiency of Artificial Intelligence educational counseling systems regarding teaching practices and the role of these technologies in changing educational interactions and personalization. AI has improved the efficiency of several domains of education in terms of how learning and teaching interact with students. To comprehensively evaluate the contribution of AI systems in the future, the study employs quantitative and qualitative research approaches. This strategy helps to make a considerable evaluation of AI's influence on teaching practices by not only the number of changes but also by the secondary qualitative data of witnesses. According to the presented research, introducing and using AI in education has numerous benefits, including delivering individualized feedback and handling educational resources more efficiently than traditional approaches. Nevertheless, it also outlines significant risks, such as ethical concerns regarding data protection, data bias, and learning technologies not adequately preparing educators to utilize these tools.

Keywords: Artificial intelligence, educational counseling, efficiency, teaching practices, personalization.

Resumen

Este artículo tiene como objetivo revisar la eficiencia de los sistemas de asesoramiento educativo de Inteligencia Artificial con respecto a las prácticas de enseñanza y el papel de estas tecnologías en el cambio de las interacciones educativas y la personalización. La IA ha mejorado la eficiencia de varios dominios de la educación en términos de cómo el aprendizaje y la enseñanza interactúan con los estudiantes. Para evaluar integralmente la contribución de los sistemas de IA en el futuro, el estudio emplea enfoques de investigación cuantitativos y cualitativos. Esta estrategia ayuda a realizar una evaluación considerable de la influencia de la IA en las prácticas de enseñanza, no solo por el número de cambios, sino también por los datos cualitativos secundarios de los testigos. Según la investigación presentada, la introducción y el uso de la IA en la educación tiene numerosos beneficios, incluyendo la



entrega de retroalimentación individualizada y el manejo de recursos educativos de manera más eficiente que los enfoques tradicionales. Sin embargo, también describe riesgos significativos, como preocupaciones éticas con respecto a la protección de datos, el sesgo de datos y las tecnologías de aprendizaje que no preparan adecuadamente a los educadores para utilizar estas herramientas.

Palabras clave: Inteligencia artificial, asesoría educativa, eficiencia, prácticas docentes, personalización.

Introduction

Artificial Intelligence (AI) is quickly becoming integrated into multiple industries and is a significant factor in reshaping education, as it can increase the efficiency of the teaching process and enhance teachers' performances through innovative technologies and the implementation of professional decision-supporting systems. Once exclusive to human counselors, educational counseling is now complemented or fully migrated to AI systems aimed at effective resource distribution, students' motivational promotion, and teachers' and learners' facilitation. The importance of AI-based educational counseling systems: Hence, there is a need to understand the prospects and consequences of incorporating such technologies in academic institutions.

This study aims to determine the integrative educational uses of AI-enabled counseling systems with an emphasis on teaching efficiency. Hoping for AI as a powerful tool to improve various aspects of education, the importance of appreciating its potential in the educational sphere should be highlighted. This research will analyze potential frameworks for implementing AI-based systems in teaching practices with a focus on customized and immediate feedback and better resource utilization. Thus, apart from identifying the benefits of integrating AI into the educational process, the potential challenges will also be discussed in the research. Some of these challenges may encompass technical problems, Ethical issues, and Teacher training. In highlighting these difficulties, the study aims to give possible intervention approaches towards those challenges. This extensive study will aid educators, policymakers, and institutions to be aware of how AI-based systems can be adopted to boost performance, yet it will also help them know about the challenges or issues arising while implementing AI-based systems. Therefore, detecting AI in education provides a comprehensive perspective of the positive impacts and the measures required to mitigate the negative. The research questions are the impact of these systems on teaching and learning and the associated challenges that contribute to their use.

Theoretical Framework or Literature Review

This section examines the current state of research on AI-based educational counseling systems and their impact on teaching effectiveness. The literature review is organized around four key themes: (1) the pedagogical impact of AI in educational counseling, (2) ethical considerations in AI implementation, (3) challenges in AI integration, and (4) strategic approaches to optimize AI use in education.

Pedagogical Impact of AI in Educational Counseling

There is a wide range of ways in which artificial intelligence has changed education, including automated grading to predictive analytics for student success (Alam, 2021; Maurya, 2023). Also within this continuum, AI-based educational counseling systems represent a tremendous leap whereby individualised advice is offered to students based on their academic performance, behavior and socio-emotional indicators. Such systems can detect students who are likely to fall behind, suggest remedial actions, and assist teachers in comprehending dynamics in the classroom better (Garg & Sharma, 2020; Bhutoria, 2022).

AI increases teaching effectiveness through learning analytics by equipping educators with tools to optimize their learning strategies to learners more effectively (Lee et al., 2022). Studies show that AI systems can contribute to differentiated instruction by providing recommendations that are congruent with the learner's learning styles, which would assist teachers in better filling learning gaps (Bilquise & Shaalan, 2022). For example, Chen et al. (2023) discovered that AI platforms can deliver useful information concerning student



learning routes, detect typical errors, and propose specific solutions. These capabilities allow for better teaching because the interventions are targeted to weaknesses and learning is supported throughout the learning process.

Several studies' empirical evidence supports the benefits of AI-integrated counseling systems on student engagement and learning outcomes. Students in a South Korean study said that AI counseling systems increased their engagement and learning effectiveness due to personalized support (Latif et al., 2021). In a similar vein, studies in Indian secondary schools showed that AI-based systems enhanced teacher-student contacts by enabling teachers to gain actionable information related to student behaviors and learning processes (Aristanto et al., 2023). These findings indicate that AI can be a powerful instrument of improved teaching practices and student learning experiences if utilized correctly.

Ethical Considerations in AI Implementation

Although AI has numerous advantages in educational counseling, some serious ethical issues must be considered. The main problem is algorithmic fairness which questions the possibility of race, gender, or the socioeconomic status bias (Dai & Ke, 2022; Tapalova & Zhiyenbayeva, 2022). Proper access and treatment in AI-based educational systems will call for a careful consideration of how they are designed tested and distributed.

The other important ethical issue is the threat of teacher autonomy erosion. Even though AI support may improve teaching potential, excessive reliance on algorithmic suggestions might reduce educators' professional opinion and decision-making power (Guleria & Sood, 2023). There is a risk that educators may rely on what AI recommends without questioning them to the detriment of their professional discretion and creativity in dealing with student needs. Educational institutions therefore need to find a balance between the use of AI capabilities and teacher autonomy.

Privacy and data confidentiality are other ethical issues concerned in AI implementation. The gathering and analyzing of large quantities of information about the students cause questions regarding the consent, security and proper way of using the personal information. As indicated by Ahmad et al. (2022), educational organizations need to define clear guidelines for handling data to ensure that student's privacy rights are protected while using the AI systems productively.

Challenges in AI Integration

Several implementation challenges are faced in the integration of AI based educational counseling systems. Wang et al. (2021) recognised insufficient teacher preparation as one of the main barriers, stating that lack of technical knowledge can make teachers resistant or misuse AI tools. This finding is corroborated by the findings made by Dahri et al. (2024) as they underlined that educators often lack the required skills to be able to use the AI systems in their teaching practice. The comprehensive training programs are therefore, crucial in empowering educators with requisite knowledge and competencies required in AI implementation.

Also, institutional and infrastructural challenges hinder AI acceptance in educational settings. Financial constraints, lack of technical support, and organizational cultures that are resistant to innovation can make the integration process highly slow (Ajlouni et al., 2023). Other concerns include the preservation of valuable human aspects of education including teacher-student relations and the growth of critical thinking where too much dependence on technology is likely to undermine the same.

Another challenge is given by the accuracy and reliability of AI recommendations. Researches have shown that some AI systems give out recommendations that are not congruent with curriculum objectives, or teacher's expectations (Aristanto et al., 2023). This limitation requires continuous human monitoring to ensure that the suggestions created by AI are suitable, realistic and in line with the objectives of education.

According to Kamalov et al. (2023), the educational institutions should develop systems for assessment and improvement of AI systems to improve their accuracy and relevance.

Strategic Approaches to Optimize AI Use in Education

To maximize the benefits of AI-based educational counseling systems while addressing potential challenges, educational institutions should adopt strategic approaches encompassing professional development, ethical guidelines, collaborative decision-making, and continuous improvement.

Professional Development

Continuous professional learning is important for teachers to be able to use AI systems in their teaching practice. Lee et al. (2022) and Stepanyuk et al. (2022) stressed that teacher training needs to include both technical aspects of AI tools and pedagogical knowledge about how to incorporate these technologies into classroom instruction. Professional development initiatives should emphasize the development of the educators' ability to use AI as a supplement that augments rather than replaces their professional expertise.

Nguyen et al. (2023) also recommended that training programs should focus on the wider implications of AI implementation, including ethical considerations and student learning experience. By gaining a holistic understanding of what AI can and cannot do, educators can make informed decisions about integrating these technologies into their teaching practices.

Ethical Guidelines

The creation of transparent ethical frameworks is essential to the responsible use of AI in education. Nazaretsky et al. (2022) called for setting guidelines that could cover such issues as algorithmic bias, data privacy, and the proper use of AI-driven recommendations. These guidelines should give specific criteria for evaluating AI systems and protocols for addressing ethical issues that might come up during implementation.

Garg & Sharma (2020) stressed the need for formal monitoring processes in order to ensure that AI systems are used fairly and equitably for a wide range of student populations. Such processes should involve periodic evaluation of AI recommendations and their effects on student outcomes, with special attention to the possible disparities across various demographic groups.

Collaborative Decision-Making

Engaging stakeholders in AI implementation decisions promotes more responsive and equitable educational technologies. Ahmad et al. (2022) recommended involving educators, students, and other relevant parties in discussions about AI integration to ensure that these systems align with the needs and values of the educational community. This collaborative approach can help identify potential concerns and develop strategies for addressing them before widespread implementation.

By fostering inclusive dialogue about AI use in education, institutions can build trust and support among stakeholders while ensuring that diverse perspectives inform technology decisions. This approach also helps establish a shared understanding of how AI tools should complement rather than replace human expertise in educational settings.

Continuous Improvement

Regular evaluation and refinement of AI systems are essential for maintaining their relevance and effectiveness in dynamic educational environments. Bilquise & Shaalan (2022) advocated for continuous monitoring of AI performance and updating algorithms based on emerging research and feedback from



users. This iterative approach enables educational institutions to address limitations, enhance capabilities, and adapt to evolving educational needs over time.

Kamalov et al. (2023) further emphasized the importance of staying informed about advancements in AI technology and educational research to ensure that implementation strategies remain current and effective. By fostering a culture of continuous learning and improvement, institutions can maximize the benefits of AI while mitigating potential risks.

Future Directions and Implications

As AI technology continues to evolve, its applications in educational counseling are likely to become more sophisticated and comprehensive. Chou et al. (2023) projected that future AI systems would offer enhanced levels of personalization and support for both students and teachers. These advancements may include more accurate predictive analytics, more nuanced understanding of student learning patterns, and more seamless integration with existing educational practices.

However, the successful integration of AI in education depends on addressing current challenges and maintaining a balanced perspective on technology's role. Rather than viewing AI as a replacement for human educators, it should be conceptualized as a complement to human expertise that enhances teaching capabilities while preserving the essential human elements of education. As noted by Guleria & Sood (2023), educational institutions must cultivate an approach that values both technological innovation and human connection in the learning process.

Conclusion

The literature reveals that AI-based educational counseling systems offer significant potential for enhancing teaching effectiveness through personalized learning support, data-driven insights, and efficient resource allocation. However, realizing these benefits requires careful attention to ethical considerations, implementation challenges, and the preservation of teacher autonomy and human connection in education. By adopting strategic approaches focused on professional development, ethical guidelines, collaborative decision-making, and continuous improvement, educational institutions can harness the power of AI while ensuring that technology serves as a tool for enhancing rather than replacing human expertise in the educational process.

Methodology

This study employs an explanatory sequential mixed-methods design to comprehensively assess the impact of AI-based educational counseling systems on teaching effectiveness. The research was conducted across various schools and higher education institutions in Saudi Arabia during the 2023-2024 academic year, involving teachers, faculty members and students from diverse disciplines.

Research Design

This study employed an explanatory sequential mixed-methods design to comprehensively examine the impact of AI-based educational counseling systems on teaching effectiveness. The quantitative phase was conducted first to establish broad patterns and statistical relationships, followed by a qualitative phase to explore these findings in depth and provide contextual understanding of participants' experiences. This design allowed for integration of data at the interpretation phase, where qualitative findings helped explain and elaborate on quantitative results.

Context and Participants

The study was conducted across five secondary schools and three higher education institution in Saudi

Arabia, during the 2023-2024 academic year. All participating institutions had planned or implemented AI-based educational counseling systems for at least one full academic year. The research focused on STEM subject areas where AI implementation was most prevalent.

Sampling Methods

A stratified purposive sampling technique was employed to ensure diverse representation across different educational levels, subject areas, and technological proficiency levels. The quantitative sample consisted of 100 teachers including higher education faculties' members (55% secondary, 45% higher education) and 100 students (60% secondary, 40% higher education) who regularly used AI-based educational counseling systems. For the qualitative phase, 10 teachers and 10 students were selected from the quantitative sample using maximum variation sampling to capture diverse perspectives and experiences.

Instrumentation and Data Collection

Quantitative data were collected through validated questionnaires adapted from the Educational Technology Integration Scale ($\alpha = 0.89$) and the AI Perception in Education Inventory ($\alpha = 0.92$). The instruments underwent pilot testing with 15 participants and expert validation by three educational technology specialists. Semi-structured interview protocols were developed based on preliminary quantitative findings and validated through expert review. Interviews lasted 45-60 minutes and were audio-recorded with participant consent.

Data Analysis Procedures

Quantitative data were analyzed using SPSS v27, employing descriptive statistics, frequency distributions, and ANOVA to identify significant relationships between variables. For qualitative data, thematic analysis following Braun and Clarke's six-step approach was used, with NVivo 14 software facilitating the coding process. Data integration occurred through a joint display approach, where quantitative results were mapped to qualitative themes to provide a comprehensive understanding of the phenomenon.

Validity, Reliability, and Bias Control

Several measures were implemented to ensure methodological rigor: (1) instrument validation through pilot testing and expert review; (2) triangulation of data sources and methods; (3) member checking of interview transcripts and preliminary findings; (4) peer debriefing sessions with colleagues not involved in the research; and (5) maintaining an audit trail documenting all methodological decisions. Two independent researchers coded 25% of the qualitative data to establish intercoder reliability (Cohen's $\kappa = 0.87$).

Ethical Considerations

The study received approval from the Institutional Review Board of Northern Border University. Informed consent was obtained from all participants, with additional parental consent for students under 18 years of age. Confidentiality was maintained through data anonymization, and participants were informed of their right to withdraw at any point without consequences.

Limitations

Despite methodological rigor, several limitations should be acknowledged: (1) the purposive sampling approach limits generalizability beyond similar educational contexts; (2) self-reporting may introduce social desirability bias, particularly regarding attitudes toward AI technologies; (3) the cross-sectional nature of the study cannot capture long-term impacts of AI implementation; and (4) findings may not be directly applicable to educational settings with significantly different technological infrastructure or cultural contexts.

Results and Discussion

This section presents and analyzes the findings from both quantitative and qualitative phases of the research, examining the impact of AI-based educational counseling systems on teaching effectiveness. The results reveal significant insights into how these technologies are transforming educational practices, while also highlighting important challenges that need to be addressed for optimal implementation.

Quantitative Findings

The impact of AI-based educational Counseling systems on teaching effectiveness

Table 1.

The impact of artificial intelligence on teaching

Impact	Number of Teachers	Percentage (%)
Notice a significant improvement in teaching	40	40%
Notice a moderate improvement in teaching	35	35%
Notice no significant change	15	15%
See a negative impact	10	10%
Total	100	100%

The findings presented in Table 1 reveal that a substantial majority (75%) of teachers perceived improvements in their teaching practice through the integration of AI-based educational counseling systems. This positive response aligns with the growing evidence of AI's transformative potential in educational settings as documented by Salas-Pilco & Yang (2022), who found similar patterns of improved instructional quality through AI-enhanced personalization. The 40% of teachers reporting significant improvement particularly noted AI's contribution to personalized learning recommendations and performance analytics that enabled more tailored instructional approaches.

However, a notable minority of teachers reported either no significant change (15%) or negative impacts (10%). These findings echo concerns identified by Selwyn (2019), who cautioned that technological integration in education often produces varied outcomes based on implementation quality, institutional support, and alignment with pedagogical goals. Teachers reporting negative impacts frequently cited concerns about inaccurate recommendations and the potential diminishment of their professional role—issues that require careful consideration as AI systems continue to evolve.

Challenges of applying artificial intelligence in educational guidance

Table 2.

Teachers' challenges

Challenge	Number of Teachers	Percentage (%)
Fear of diminishing the teacher's role	30	30%
Need for additional training	25	25%
Problems with the accuracy of recommendations	20	20%
Lack of technical resources	15	15%
Privacy concerns	10	10%
Total	100	100%

The distribution of challenges illustrated in Table 2 reveals significant concerns about the integration of AI technologies into educational practice. The predominant concern about diminishing the teacher's role (30%) reflects broader tensions in the educational technology literature. Chan and Tsi (2024) similarly

identified professional identity concerns among educators, who feared that AI might eventually supplant rather than supplement human instruction. This anxiety suggests the need for implementation approaches that explicitly position AI as a tool to enhance rather than replace teacher expertise.

The substantial need for additional training (25%) corresponds with findings from Zawacki-Richter et al. (2019), who identified inadequate professional development as a critical barrier to effective AI integration. This challenge intersects with concerns about recommendation accuracy (20%), as teachers without sufficient understanding of AI systems may struggle to effectively interpret, contextualize, and override algorithmic suggestions when necessary.

Infrastructure limitations (15%) and privacy concerns (10%) represent additional barriers that align with the digital equity issues identified by Maurya (2023), who emphasized the importance of addressing technological access gaps to avoid exacerbating educational disparities through AI implementation.

Table 3.
Students' challenges

Challenge	Number of Students	Percentage (%)
Lack of confidence in the accuracy of recommendations	55	55%
Difficulty interacting with the system	20	20%
Lack of knowledge of how to use it	15	15%
Privacy concerns	10	10%
Total	100	100%

Student perspectives on AI challenges reveal notable differences from teacher concerns, with a pronounced emphasis on recommendation accuracy (55%). This marked skepticism about AI reliability confirms observations by Yola et al. (2024), who found that students often question AI-generated content that contradicts information provided by human instructors. This lack of confidence represents a significant barrier to adoption that could undermine the potential benefits of AI systems if not addressed through improved algorithms and transparent explanation of AI reasoning.

User experience challenges (20%) and knowledge gaps (15%) further impede effective student engagement with AI systems. These findings align with research by Seo et al. (2021), which demonstrated that non-intuitive interfaces can significantly impact student willingness to engage with educational technologies. Interestingly, privacy concerns were less prominent among students (10%) than might be expected given the extensive data collection involved in personalized AI systems, suggesting the need for greater awareness of data protection issues among learners.

Improving the use of artificial intelligence in teaching practices

Table 4.
Ways that may improve the use of artificial intelligence in teaching

Proposal	Number of Teachers	Percentage (%)
Provide training courses for teachers	45	45%
Improve the accuracy of recommendations	30	30%
Enhance integration with curricula	15	15%
Provide ongoing technical support	10	10%
Total	100	100%

Teachers' recommendations for improving AI implementation demonstrate a clear prioritization of professional development (45%), closely followed by algorithmic enhancement (30%). The strong

emphasis on training aligns with findings from Hazzan-Bishara et al. (2024), who identified teacher preparation as the most significant factor in successful educational technology integration. This suggests that technical solutions alone are insufficient without corresponding investment in human capacity building. The substantial concern with recommendation accuracy (30%) reflects a critical tension in AI educational applications: systems must provide reliable guidance to maintain credibility while acknowledging the inherent complexity and contextual nature of educational processes. This challenge was similarly documented by Kasztelnik (2024), who found that AI algorithms often struggled to fully align with curriculum objectives and pedagogical intentions.

The identified need for better curriculum alignment (15%) and ongoing technical support (10%) further underscores the importance of embedding AI within existing educational structures rather than imposing it as a separate or parallel system. These findings echo the recommendations of Kour et al. (2021), who advocated for collaborative approaches to AI implementation that involve educators in system design and continuous improvement processes.

Synthesis of Quantitative Findings

The quantitative data reveals a complex implementation landscape for AI-based educational counseling systems. While a majority of educators perceive positive impacts, significant challenges persist related to professional roles, technical capacity, algorithmic accuracy, and system integration. These findings align with the broader literature on educational technology adoption, which consistently identifies the need for balanced approaches that address both technical and human dimensions of innovation.

A particularly noteworthy pattern in the data is the apparent disconnect between students' and teachers' perceptions of AI systems. Teachers demonstrate greater concern about professional role displacement, while students focus more intensely on the practical reliability of AI recommendations. This divergence suggests the need for implementation strategies that address the distinct needs and concerns of different stakeholder groups.

Qualitative Findings

The impact of AI-based educational guidance systems on teaching effectiveness

Table 5.
Teacher interviews

Emergед themes	Number of teachers	Quote
Improved planning and teaching	6	"I have a clearer view of students' levels, as the system suggests study plans tailored to each student's needs, which has made teaching more effective."
Increased student engagement	4	"Students are more engaged in lessons, especially when they receive personalized recommendations that help them understand the material at their level."
Reduced administrative burden	3	"I used to spend long hours grading tests, but now I can invest that time in delivering more interactive teaching experiences."



Table 6.
Student interviews

Emergед themes	Number of Students	Quote
Enhancing personal understanding	7	"When I don't understand a particular lesson, the AI provides me with a simplified explanation in different ways, which makes the subject much easier."
Motivation to Learn	5	"I like using educational apps because they make studying feel like a fun game, which motivates me to study for longer periods."
Overreliance	3	"When I have homework, I sometimes resort to AI to solve it quickly instead of trying to solve it myself, and this makes me less diligent."

The qualitative data provides rich contextual understanding of how AI systems influence teaching practices and learning experiences. Teachers' narratives emphasize AI's facilitative role in instructional planning, with six educators specifically highlighting the value of data-driven insights for personalizing instruction. This finding aligns with research by Rizvi (2023), who documented how AI-enhanced analytics can significantly improve teachers' ability to respond to diverse learning needs through more targeted interventions.

The theme of increased student engagement (reported by four teachers) corresponds with findings from Huang et al. (2021), who found that personalized learning experiences generated by AI systems often produce greater student interest and participation. This engagement effect appears to operate through mechanisms of appropriate challenge and cognitive scaffolding, as AI systems can match content difficulty to individual readiness levels more precisely than standardized approaches.

Teachers' appreciation of reduced administrative burden reflects the potential of AI to address a persistent challenge in education: balancing instructional quality with workload manageability. By automating routine assessment tasks, AI systems allow teachers to redirect time toward higher-value pedagogical activities—a benefit documented by Bahroun et al. (2023) in their analysis of AI effects on teacher workload distribution.

Student perspectives reveal complementary themes, with a majority (7) valuing AI's role in providing alternative explanations that enhance comprehension. This finding supports the concept of AI as a "cognitive scaffold" that can adapt explanatory approaches to individual learning preferences. The gamification elements noted by five students align with research by Joshi et al. (2021) on motivational aspects of educational technology, suggesting that AI systems can harness engagement mechanisms from game design to sustain learning effort.

However, the theme of overreliance identified by three students raises an important concern about potential negative impacts on independent learning skills. This tension between helpful support and dependency echoes Selwyn's (2019) cautionary analysis of educational technology's dual potential to both enhance and undermine student agency. As one student noted, the convenience of AI assistance sometimes displaces the productive struggle that builds deeper understanding and self-reliance—a consideration that must inform implementation approaches.

Challenges of applying artificial intelligence in educational guidance

Table 7.

Results of interviews with teachers

Emergед themes	Number of teachers	Quote
Inaccuracy in recommendations (teachers)	5	"Sometimes the system suggests learning plans that don't match the students' actual level, which makes me rely on it with caution."
Need for additional training	4	"Technology is great, but I find it difficult to use it to its full potential. We need dedicated workshops to learn how to apply it in teaching."
Concern about performance evaluation	3	"I fear that some may think that AI can replace us as teachers, when in fact it should be a supportive tool, not a substitute."

Table 8.

Student Interviews

Emergед themes	Number of students	Quote
Distrust of AI	6	"Sometimes I get a completely different answer than what the teacher explains in class, which makes me question the validity of the information."
Lack of access to technology	4	"Not all students have tablets or fast internet, which makes some unable to benefit from smart tools in the same way we do."
Boredom from robotic systems	3	"When I use AI for a long time, I feel like I'm learning from a soulless robot. I miss the interactive style of teachers."

The qualitative analysis of the implementation challenges identifies subtle concerns that build on the quantitative findings. The teachers' reports of recommendation inaccuracy (5 participants) can be seen to identify the underlying limitation of the existing AI systems: the difference between algorithmic predictions and the intricate reality of student learning requirements. This challenge is congruent with findings of Slimi (2021), who reported that AI recommendations did not take into consideration key contextual factors which seasoned educators were aware of. The precise nature of these inaccuracies usually entails a gap between what is anticipated to be the capabilities of the students and actual preparedness for performance—a gap that calls for teacher intervention and correction.

The stated need by teachers for more training (4 participants) provides a glimpse of what type of professional development is necessary. While general technology orientation was not discussed, participants specifically mentioned the need for "dedicated workshops" for pedagogical application, a finding in line with Salas-Pilco & Yang (2022), who found that effective AI integration was not possible without development approaches that place technology within teachers' instructional practice rather than as a separate technical skill.

The issues of performance evaluation and professional identity (3 teachers) point to the psychological dimension of the implementation of AI. Apart from practical issues, such systems bring about questions regarding how teaching effectiveness will be defined and measured in technology-enhanced settings. This anxiety captures a broader set of professional concerns, as noted by Guleria & Sood (2023) on the issue of teacher autonomy amidst growing algorithmic influence on educational decision making.

Student opinions regarding challenges identify significant implementation barriers, with distrust of AI (6 participants) being the foremost issue. Such skepticism is often caused by contradictions between AI-

provided information and teacher instruction, leading to cognitive dissonance among the learners. The quote “Sometimes I get a completely different answer than what the teacher explains in class” serves as a good example of this conflict which Maghsudi et al. (2021) described as a major obstacle to the acceptance of AI educational tools by students.

The ethical dimension of AI implementation, which goes beyond technical issues, is highlighted by the concern expressed by four students regarding the digital divide. As Limna et al. (2022) state, unequal access to technology may worsen pre-existing inequalities in education if digital tools become a key part of the learning process. This discovery highlights the need for inclusive implementation strategies that promote equitable access to AI resources.

The topic “boredom from robotic systems” (3 students) describes an affective limitation of current AI systems, which is less discussed in the literature on implementation (earlier, this issue was discussed in the literature on design). With all its increasing capacities, AI interfaces still are devoid of the emotional intelligence and interpersonal warmth of effective human teaching – qualities that Algahtani (2024) identified as especially influencing student involvement with educational technologies. This finding implies that effective implementation of AI must supplement but not replace human interaction in learning environments.

How to improve the use of artificial intelligence in teaching

Table 9.

Teachers interview results

Emergед themes	Number of teachers	Quote
Provide specialized training for teachers	6	"If we could get hands-on training on AI tools, we could greatly improve the learning experience for students."
Improve the accuracy of educational recommendations	4	"Sometimes, AI systems provide general recommendations that don't suit all students. We need to improve these systems to provide more personalized content."
Integrate AI in a complementary way	3	"AI should be an assistant to the teacher, not a replacement. Technology cannot replace human interaction between teacher and student."

Table 10.

Students interview

Emergед themes	Number of students	Quote
Developing the user experience	5	"Some smart tools are too complex. If they were simplified, it would be more beneficial for us to use them."
Making AI accessible to everyone	4	"Not all students have the same access to technology. There must be support to ensure equality in education."
Balancing AI and human interaction	3	"AI can be useful, but nothing replaces the presence of a teacher in the classroom and direct interaction with them."

Teachers' recommendations for improvement focus on practical suggestions for improving AI integration. The main recommendation for professional training (6 participants) is more than a general introduction to technology and it is about the utilization of AI tools in the pedagogical setting. This particular focus on “hands-on training” corresponds with Hazzan-Bishara et al.'s (2024) finding that experiential professional development is more effective in integrating technology than theoretical training alone. The quote “improve the learning experience for students” further shows that teachers conceptualize AI training as being

pedagogically driven, rather than technologically driven.

The recommendation to enhance recommendation accuracy (4 teachers) reveals various algorithmic limitations that are of concern to practitioners. The fact that the AI systems “offer general recommendations that do not fit all students” points to the conflict between algorithmic standardization and contextualized nature of effective teaching. This critique chimes with Kasztelnik’s (2024) analysis of the gap between algorithmic patterns and pedagogical nuance in current AI education.

The theme of complementary integration (3 teachers) represents a subtle insight into AI’s correct use as a learning aid. Instead of framing technology and human instruction as antagonistic methods, these teachers imagine a complementary dynamic where the AI complements rather than replaces the expertise of the teacher. This view corresponds to the notion of “augmented teaching” (Guleria & Sood, 2023), where the distinct contributions of human and artificial intelligence to the educational process are highlighted.

Student recommendations show different priorities, while improvement of user experience (5 participants) is the main concern. The fact that “some smart tools are too complex” points to usability as a major barrier to effective use of AI systems. This finding corroborates the research of Seo et al. (2021), who showed that the design of interfaces plays a decisive role in influencing student readiness to use educational technologies.

The theme of equitable access (4 students) shows the understanding of digital divide problems within learners. This concern overflows the individual experience to acknowledge systemic inequities as seen in the observation that “there must be support to ensure equality in education”. This line of thought concurs with the ethics of educational technology proposed by Maurya (2023) and Funa & Gabay (2025) with access equity as a core implementation principle.

The interest in balanced human-AI interaction (3 students) indicates that even digital natives want human connections in educational experiences. The claim that “nothing replaces the presence of a teacher in the classroom” undermines the implementation approaches based solely on efficiency and agrees with the finding by Bahroun et al. (2023) that effective educational technologies supplement human interaction in the learning environment instead of replacing it.

Integrated Discussion and Implications

The combination of the quantitative and qualitative findings exposes several crucial patterns with profound implications for the implementation of AI-based educational counseling systems. First of all, while AI technologies provide great advantages for teaching effectiveness through personalization, analytics, and administrative efficiency, all these advantages depend on proper implementation conditions such as sufficient training, technical support, and careful integration with the existing pedagogical practices.

Second, the findings identify key differences of stakeholders in perception and priority when it comes to AI systems. Teachers are more concerned about professional role implications and implementation support, in contrast to students who concentrate more on usability, reliability, and sustaining meaningful human connection in learning experience. The varied views indicated above point to the requirement of implementation strategies that would accommodate the varied concerns of various stakeholders in the education system.

Third, the research determines key ethical aspects of AI implementation outside of technical functionality. Data privacy, algorithmic bias, digital equity, and professional autonomy become key concerns that must guide the responsible integration of AI in the educational context. According to Dai & Ke (2022) and Funa & Gabay (2025), ethical frameworks and technical capabilities should be designed hand in hand so that AI can support rather than undermine the values of education.

Fourth, both quantitative and qualitative findings emphasize the need for human-AI collaboration as opposed to technological replacement. The best practice models of implementation frame AI as complementing rather than replacing the teacher's expertise-a supplementary tool that augments human abilities without sacrificing the core relational aspects of effective education. This finding also concurs with Guleria & Sood's (2023) conceptualization of "augmented teaching" as a joint venture between human discretion and algorithmic ability.

The implications of the study's findings are profound for educational practice and policy. In the institutional sphere, successful AI implementation entails significant investment in professional development, technical infrastructure, and continued support systems. The high percentage (45%) of teachers identifying training needs highlights the role of capacity building as a pre-requisite for successful technology integration.

At the pedagogical level, the evidence points to the necessity of reflective implementation strategies which allow teachers to exercise agency in educational decision-making. The concern about a reduction of professional roles (30% of teachers) suggests that the implementation models should specifically maintain room for teacher judgment and creativity in AI-aided learning environments.

At the policy level, the noted challenges of technical access and data privacy indicate the need for regulatory frameworks that guarantee equitable implementation and prevent the leakage of student information. The concerns over the digital divide brought up by the students point to the danger that AI implementation might not help but rather worsen the educational inequalities if access policies are not regulated.

Finally, the algorithmic limitations in the findings of the study – particularly the issues around the accuracy of recommendations – have implications for the technical development of educational AI systems. The high number of both teachers (20%) and students (55%) who are concerned about the quality of recommendations indicates that existing systems have not yet managed to generate adequate alignment with pedagogical needs and contexts. This finding points to the necessity for collaborative development approaches that integrate the expertise of educators into the design process of AI.

In conclusion, the combination of quantitative and qualitative findings shows that AI-based educational counseling systems have great potential for improving the effectiveness of teaching, but this potential needs to be developed with regard to human, ethical, and institutional aspects of implementation as well as technical functionality. Balancing technological improvements with preservation of the core human aspect of effective education is a difficult task that requires the collaboration of educators, technologists, and policymakers for its successful implementation.

Conclusions

This explanatory sequential mixed-methods study investigated the effects of AI-based educational counseling systems on teaching effectiveness in educational institutions in Saudi Arabia. Using quantitative surveys of 100 teachers and 100 students and in-depth interviews of 10 members of each group, the research found that there are intricate patterns of benefits and challenges for utilization of AI in educational contexts.

The results show that AI-based educational counseling systems have great potential for improving teaching effectiveness through three main mechanisms: Personalized learning support according to the needs of individual students, (2) data-driven insights that guide instructional decision-making and (3) automation of routine administrative procedures that enable teachers to devote more attention to high-value pedagogical activities. Quantitatively 75% of teachers reported improvement in their teaching practice with the integration of AI, qualitatively there was a specific report of benefits in instructional planning, student engagement and workload management.

Nonetheless, the research also revealed significant implementation challenges that need to be overcome



to tap into the educational potential of AI. These are concerns about professional role displacement (reported by 30% of teachers), inadequate training and technical support (25% of teachers), algorithmic limitations in recommendation accuracy (20% of teachers and 55% of students) and ethical issues on privacy of data and equitable access. The qualitative findings further uncovered significant affective aspects of AI implementation, with some students expressing their reduced engagement with the “robotic” systems, as opposed to human instruction.

The study’s results place AI implementation in a wider discussion of technology’s role in educational change. Instead of presenting AI as a panacea or threat to quality education, the findings imply the necessity of a more complex approach with the use of technological capabilities, but with the preservation of the most important human aspects of the teaching and learning process. This balanced view is consistent with the idea of “augmented teaching” by Guleria & Sood (2023), which stresses the complementary nature of human expertise and algorithmic capabilities in the educational context.

Limitations

Some limitations of the current study should be recognized. The purposive sampling approach reduces generalization outside similar educational contexts, especially to areas with markedly different technological infrastructure or attitudes towards AI. The cross-sectional design captures perceptions at a given point in AI’s fast-paced evolution rather than following change over time. Also, self-reported perceptions may not correspond to objective measures of teaching effectiveness – a relevant point for future research.

Based on the integrated findings, we propose four key recommendations for optimizing AI implementation in educational settings:

1. **Invest in Comprehensive Professional Development:** Educational institutions should prioritize hands-on, pedagogically-focused training that equips teachers to integrate AI tools effectively into their instructional practice. This training should address both technical competencies and critical evaluation of AI recommendations, positioning teachers as informed users rather than passive recipients of algorithmic guidance.
2. **Establish Ethical Guidelines and Governance Frameworks:** Clear standards for data privacy, algorithmic transparency, and equitable implementation should guide AI adoption in educational settings. These frameworks should be developed collaboratively with input from diverse stakeholders, including educators, students, technical experts, and privacy advocates.
3. **Foster Collaborative Human-AI Systems:** Implementation approaches should explicitly position AI as augmenting rather than replacing teacher expertise, with clear delineation of appropriate roles for human judgment and algorithmic analysis in educational decision-making. This collaborative model preserves teacher autonomy while leveraging AI capabilities for enhanced instructional effectiveness.
4. **Ensure Equitable Access and Support:** Educational institutions must address digital divide concerns through infrastructure investment, device access programs, and technical support systems that ensure all students can benefit from AI-enhanced learning opportunities regardless of socioeconomic status or geographic location.

Future Research

Further research is needed to expand this inquiry in various directions. Longitudinal studies that follow the evolution of AI implementation over long periods would shed more light on sustainability and long-term impact. Comparative analysis in various cultural and institutional settings may identify contextual factors which affect implementation effectiveness. Furthermore, studies focusing on specific mechanisms through which AI systems affect teaching practices and student outcomes would aid in refining implementation strategies for optimal educational gains.

In conclusion, AI-based educational counseling systems are a powerful but a two-edged sword for improving the effectiveness of teaching. Their successful integration does not hinge on technological sophistication alone, but rather on thoughtful consideration of human, ethical, and institutional aspects of educational practice. Through balanced implementation strategies that marry technological innovation with preservation of important human connections, institutions of learning can leverage AI's potential while upholding relational underpinnings of effective teaching and learning.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.3>

Cómo citar:

Zybin, S., Bondarchuk, O., Piroh, O., Suprun, O., & Kyshakevych, S. (2025). Cybersecurity on Ukrainian Higher Education: Threats and protection measures. *Revista Eduweb*, 19(2), 38-52. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.3>

Cybersecurity on Ukrainian Higher Education: Threats and protection measures

Ciberseguridad en la Educación Superior Ucraniana: Amenazas y medidas de protección

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Recibido: 01/04/25

Aceptado: 15/05/25

Abstract

The purpose of the study is to analyse the impact of cybersecurity on higher education in Ukraine, identify key threats and formulate key recommendations for improving the security of educational institutions. For this purpose, a cross-sectional survey study has been chosen. A purposive sample has been used to include participants. 79 questionnaires have been received; five have been rejected, and three more have refused to consent to data processing. The study involved 71 people, including 15 administrative staff (IT departments, managers), 30 teachers, and 26 students. The primary tool in the study has been a cross-sectional questionnaire survey conducted in the same period for all participants from 11/20/2024 -



12/20/2024. The results indicate that the main cybersecurity threats in Ukrainian educational institutions are viruses and malware (39,4%), hacking of university platform accounts (26,8%), phishing attacks (14,1%), and personal data leakage (12,7%). The results also have showed that 49,3% of respondents are moderately aware of cybersecurity measures at the university, while 28,2% are poorly aware. The conclusions summarise that to ensure cybersecurity further, it is necessary to expand multi-level protection systems, control the use of the Internet, and conduct additional training for students and teachers in cybersecurity.

Keywords: Cyber hygiene, intellectual property protection, national strategy, technology, privacy policy.

Resumen

El objetivo del estudio es analizar el impacto de la ciberseguridad en la educación superior en Ucrania, identificar las principales amenazas y formular recomendaciones clave para mejorar la seguridad de las instituciones educativas. Para ello, se optó por un estudio de encuesta transversal. Se utilizó una muestra intencionada para incluir a los participantes. En el estudio participaron 71 personas, entre ellas 15 miembros del personal administrativo (departamentos informáticos, directivos), 30 profesores y 26 estudiantes. La herramienta principal del estudio fue una encuesta transversal por cuestionario realizada en el mismo periodo para todos los participantes: del 20.11.2024 al 20.12.2024. Los resultados indican que las principales amenazas a la ciberseguridad en las instituciones educativas ucranianas son los virus y el malware (39,4%), el pirateo de cuentas de la plataforma universitaria (26,8%), los ataques de phishing (14,1%) y la filtración de datos personales (12,7%). Los resultados también mostraron que el 49,3% de los encuestados tiene un conocimiento moderado de las medidas de ciberseguridad en la universidad, mientras que el 28,2% tiene un conocimiento escaso. Las conclusiones concluyen que, para garantizar aún más la ciberseguridad, es necesario ampliar los sistemas de protección multinivel, controlar el uso de Internet y proporcionar formación adicional a estudiantes y profesores sobre los fundamentos de la ciberseguridad.

Palabras clave: Protección de la propiedad intelectual, tecnología, política de privacidad, ciber higiene, estrategia nacional.

Introduction

Digital technologies play an essential role in higher education and contribute to the development of the educational process, research and university administration. However, despite the numerous opportunities identified in scientific studies (accessibility of education, speed, convenience of obtaining educational information), the digitalisation of education also creates new challenges (Korhonen et al., 2021).

The field of cybersecurity is particularly affected. The growth of cyber threats, including hacker attacks, data breaches, phishing attacks, and malware, threatens the confidentiality of student and teacher data, the stability of educational platforms, and trust in the digital learning environment. In addition, Ukraine, which is currently in a state of hybrid war, faces significant risks in cyberspace, which is especially relevant for higher education and science.

Scientific works indicate that attacks on educational institutions lead to disruptions in the educational process and compromise research and academic integrity violations (Melenti et al., 2024; Nehrey et al., 2022). Therefore, this scientific problem is particularly relevant in the modern scientific space and requires careful analysis. In this regard, there is a need to analyse the main cyber threats and develop effective measures to protect the information space of Ukrainian universities.

The main research problem is the growing vulnerability of Ukrainian higher education to cyber threats due to insufficient security of digital platforms, lack of a comprehensive cyber defence strategy, and limited awareness of safe online behaviour among participants in the educational process. In addition, the lack of



effective mechanisms for responding to cyberattacks can lead to the leakage of confidential information, disruptions in the learning process, and undermine trust in the digital learning environment.

The focus of this paper is to provide a detailed analysis of the leading cyber threats affecting higher education in Ukraine and assess the effectiveness of existing protection measures. This will be done through a comprehensive survey of all participants in the educational process: teachers, students, and administration. The paper will address such aspects as the vulnerability of educational platforms to attacks, the level of digital literacy of teachers and students, and the state policy of cyber defence in times of war.

Therefore, the purpose of this study is to assess the impact of cybersecurity on higher education in Ukraine, identify key threats, and formulate key recommendations for improving the security of educational institutions. Accordingly, the main research questions are as follows:

1. What are the most common cyber threats in higher education?
2. What is the level of educational process participants' awareness of ensuring an adequate digital space?
3. What recommendations can be offered to improve cybersecurity in higher education?

The main research hypotheses that need to be confirmed or refuted:

1. Modern higher education institutions implementing systemic cybersecurity measures (multi-level authentication and regular system updates) have a significantly lower cyber threat.
2. The higher the level of digital competence of faculty and students, the lower the risk of cyberattacks on university learning systems.

The structure of this article is formed as follows: a review of the literature, which presents an analysis of existing modern works, methodology, which explains the procedure of data collection and analysis, results, which present the impact of the main cyber threats on the development of the education system, discussions, which describe the key discussions of the results and their comparison with other works. The last section is conclusion, which briefly describes the main identified cyber threats and their impact on the development of education.

Literature Review

Theoretical foundations for the formation of cybersecurity in an educational institution

Modern scholars have described various aspects of the impact of cybersecurity on the organisation of the educational process. According to several modern studies, the use of digital technologies has sharply intensified in recent years and decades in almost all countries and has covered all areas of activity (AIDaajeh et al., 2022; Blažič, 2021).

Despite the identified numerous advantages (accessibility and efficiency) of obtaining information, the use of digital technologies also poses specific threats, in particular, the complexity of data protection for individuals, firms, authorities, and societies in general (Terepyshchyi & Kostenko, 2022). Recent studies have shown that the development of an effective cybersecurity system in education should be based on systemic and interdisciplinary approaches that synthesise technical, organisational, and legal aspects (Horlynskyi & Horlynskyi, 2019; Lakhno et al., 2024; Zabasta et al., 2020).

Cybersecurity research points to the importance of formulating a cybersecurity strategy for an educational institution, which should include access policies, monitoring of network activity, and data backup (AIDaajeh et al., 2022). The works of some scientists point to the importance of using a concept called "Zero Trust Security". The latter implies constantly checking all users and technical devices in the learning environment (Haque et al., 2023).

At the same time, not all researchers support this idea. In particular, other works describe that international cybersecurity standards such as ISO/IEC 27001 are recognised and effective in protecting educational institutions. Zhyvko et al. (2020) describe the main legal conditions for ensuring effective regulation of cyberspace. On the other hand, some scholars point out the critical role of public policy in the cybersecurity system, in particular, educational institutions must comply with GDPR data security standards, which are fully recognised in the European Union (Zhyvko et al., 2020; Potii et al., 2015).

Opportunities and threats in the digital learning space

The works of scientists indicate that forming a digital learning space opens up many advantages related to the accessibility of learning and the speed of knowledge acquisition (Bohomaz et al., 2023; Bingham, 2024). Other scholars also point to such advantages as the introduction of new methods and forms of learning that promote greater student engagement and increase their level of motivation.

In addition, according to Khan et al. (2022), the digital learning environment opens up new opportunities for distance and blended learning. Scientists point out that platforms such as Moodle, Google Classroom, and Microsoft Teams facilitate interactive learning and effective collaboration between students and teachers (Korhonen et al., 2021).

Devadze & Gechbaia (2024) found that virtual reality can increase students' learning motivation. However, despite several advantages, some challenges have also been identified in scientific research. In particular, the authors point to the threat of cyberattacks on educational institutions.

Modern universities are becoming targets for hackers because they store confidential data of employees and students. In addition, several works point to the problem of phishing attacks (Ulven & Wangen, 2021). These authors summarised that students' and teachers' lack of security awareness makes them vulnerable to fraudulent schemes, including in the digital learning space.

It is also worth paying attention to hacking and data leakage, as shown in the research of Sullivan & Kamensky (2017). In particular, these researchers determined that the lack of two-factor authentication contributes to the compromise of learning platform accounts (Guchua & Zedelashvili, 2023; Kharlamova et al., 2022).

On the other hand, scientists have drawn attention to the global problem of artificial intelligence and deep fakes, which have begun to be actively used in education. However, the widespread use of generative AI technologies can lead to information manipulation and affect academic integrity.

Key cybersecurity measures

According to modern works, ensuring Ukraine's cybersecurity is a state of protection for the interests of a person, society, and the state in cyberspace should be achieved through several legal, organisational, and informational measures. The latter should also be based on the effective organisation of professional training of cybersecurity management specialists.

Cheng & Wang (2022) state that to protect information from unwanted interference, cybersecurity measures are implemented, which should be understood as systemic actions of a technological, organisational, economic, and legal nature. These measures should be designed to be purposefully carried out to identify and destroy cyber threats (Galushchenko et al., 2024; Guo, 2023).

Most studies point to the need to introduce innovative approaches to cybersecurity in educational institutions. In particular, the works consider such a measure as cybersecurity policy development (Melenti et al., 2024; Bobro et al., 2024). According to Dei et al. (2024), forming internal security standards governing access to resources and data storage plays an important role. However, not all scholars agree with this statement.

There are arguments that these measures are not enough. Thus, other authors point out that technical security measures should be considered, and continuous monitoring should be conducted (Melenti et al., 2024; Nehrey et al., 2022). Some authors emphasise increasing digital literacy among students and teachers (Kuzminykh et al., 2021).

The study by Buriachok et al. (2023) describes the main aspects of introducing cybersecurity education, which is currently a relevant area. Zhao et al. (2021) also describe the main complex and key conditions for forming digital competence.

The analysed works mostly use a qualitative approach to data analysis. Also, in some works there is a rather broad overview aspect (Buriachok et al., 2023; Melenti et al., 2024). Accordingly, there is a lack of analysis of statistical and quantitative data. In some works, although there is quantitative data, the authors did not widely discuss the obtained results.

The main limitations of these studies are the increased attention to the qualitative overview type. In addition, the vast majority of works are of an overview nature. This requires additional research involving experimentation. Accordingly, the main gaps are as follows:

1. Too much attention to theoretical research.
2. There is a lack of empirical works.
3. Too many reviews.
4. Insufficient analysis of new threats that appear in modern cyberspace.

Therefore, given that there is currently no unanimous solution to define effective cybersecurity measures in scientific works, it is worth revisiting all these measures and identifying the most effective ones. This should be done by surveying all participants in the educational process. This study will fill this gap, identify the main cyber threats, and provide recommendations for their elimination.

Methodology

Research design

A cross-sectional survey study has been chosen for this research. This type of research allows for a survey among different categories of participants in the educational process: students, teachers, and administration. Therefore, it enables us to analyse the opinions of other people at the same time. This type has been chosen because of its advantages, including obtaining information from different people and the speed of its processing. The study has been conducted from 11/20/2024 to 12/20/2024. Location - higher education institutions of Ukraine.

Sample and participants

A purposive sample has been used for this study. The inclusion criteria have been based on the following aspects:

1. Teaching OR studying in a higher education institution (two years of teaching experience).
2. Information security professionals working in universities.
3. Experience in protecting educational information systems.
4. Understanding cybersecurity and how it is implemented in an educational institution.
5. Professional experience in cybersecurity, information technology or administration of educational processes.
6. Persons who regularly use digital platforms for learning, management or administration in the educational environment (Moodle, Google Classroom, Microsoft Teams, etc.).
7. Location: Representatives of Ukrainian higher education institutions (public and private) who work or



- have studied in Ukraine are eligible.
8. Voluntary consent to participate.

The exclusion criteria have been also preliminarily formed:

1. Persons with no experience in the field of cybersecurity.
2. Persons with no experience in modern educational digital technologies were excluded.
3. Representatives of companies working in cybersecurity but without experience cooperating with educational institutions.

Participants have been recruited by distributing the survey announcement via corporate emails. A total of 79 questionnaires have been received. However, not all participants met the pre-established criteria.

Therefore, five questionnaires have been rejected, and three more have refused to consent to data processing. Thus, 71 people have been included in the study. The study consists of the following categories:

1. Administration (IT departments, managers);
2. Teachers (especially those who work with digital platforms);
3. Students (users of educational systems).

Table 1 provides detailed information about all participants.

Table 1.
Data of the participants.

Nº	Category	Number (N)	%	Average age	Gender (M/F)	Work experience (years)	Use of digital platforms
1	Administration	15	21,1%	38	10/5	10	+
2	Teachers	30	42,3%	45	19/11	15	+
3	Students (users of educational systems)	26	36,6%	21	12/14	-	+
	Total	71	100%	35	42/29	12	+

Source: Author's development

Instruments and procedure

The main instrument in the study was a cross-sectional questionnaire survey. It has been conducted in the same period for all participants: from 11/20/2024 to 12/20/2024.

The survey has been designed to explore the main opportunities and threats to cybersecurity in modern digital space.

The survey also focused on the mechanisms implemented in educational institutions to ensure a secure digital space and protect the data of teachers and students.

The questionnaire also contained both closed and semi-open questions. This made it possible to determine the level of awareness of participants about cybersecurity measures and their experience of facing cyber threats. Respondents filled out the questionnaire online via Google Forms. This allowed us to collect and structure responses effectively.

The questionnaire has been distributed through official university channels, such as e-mail and internal

portals, as well as professional teachers' communities. Table 2 shows the main structure of the survey.

Table 2.
Structure of the questionnaire.

Part of the questionnaire	Key questions
1. Data	1. Please indicate your role in the higher education institution: administration, faculty, student 2. Your age 3. Your gender 4. Please indicate your experience in education (for faculty and administration) 5. Do you use digital educational platforms in your work/study?
2. Experience with cyber threats	6. Did you face any cyber threats while studying or teaching? 7. How often did this happen?
3. Basic security measures	8. How aware are you of the cybersecurity measures at your university? (on a scale from 1 to 5) 9. What measures do you consider effective? 10. Does your university have an official cybersecurity policy? (Yes or No) 11. Have you received formal cybersecurity training? (Yes or No)
4. Assessment of the effectiveness of measures	12. How would you rate the effectiveness of cybersecurity measures in the educational institution where you work or study? (on a scale from 1 to 5) 13. How secure do you feel when using university digital resources? 14. What measures should be optimised in the field of cybersecurity in universities?

Source: Author's development

Data analysis

After collecting responses, the data has been processed and analysed using quantitative and qualitative analysis methods. First, all responses have been exported from Google Forms to Excel for further processing. Microsoft Excel was chosen because of its accessibility and ease of data processing.

First, the data have been cleaned to remove invalid or incomplete answers. Then, discrete variables (in particular, categories of respondents, level of awareness, and performance assessments) have been coded for further processing. Descriptive statistics were used to analyse the main trends, and frequencies have been calculated for categorical variables (for example, the frequency of encountering cyber threats).

Open questions have been subjected to thematic analysis. In particular, similar central answers have been first grouped into categories (e.g., the main cyber threats and security measures proposed by participants), and key trends have been identified. The potential of Microsoft Excel was used to present the results, particularly the diagrams of the distribution of responses.

Validation

The questionnaire was specifically designed to assess the impact of modern approaches to resolving intergenerational conflict in education. In order to ensure content validity, the questionnaire was validated by a panel of three experts in educational psychology and conflict resolution. Their feedback led to changes in the wording and structure of the questions for better clarity and relevance.

Ethical considerations

The study adhered to ethical standards in educational research. Informed consent was obtained from all participants after they were provided with detailed information about the purpose of the study. Participation was completely voluntary and anonymous. Responses were securely stored and subsequently analysed.

Results and Discussion

Digital technologies have increased dramatically in the Ukrainian higher education system in recent years. While implementing these technologies has some advantages (accessibility and efficiency of information), there are also some threats regarding the complexity of data protection for individuals and the entire educational institution. In particular, only 7% of respondents have not encountered cyber threats while studying or teaching.

The most common cybersecurity threats were viruses and malware (39.4%). 26.8% of cases involved hacking university platform accounts. Another 14.1% and 12.7% suffered from phishing attacks and personal data leakage. Figure 1 shows the percentage distribution of participants' responses.

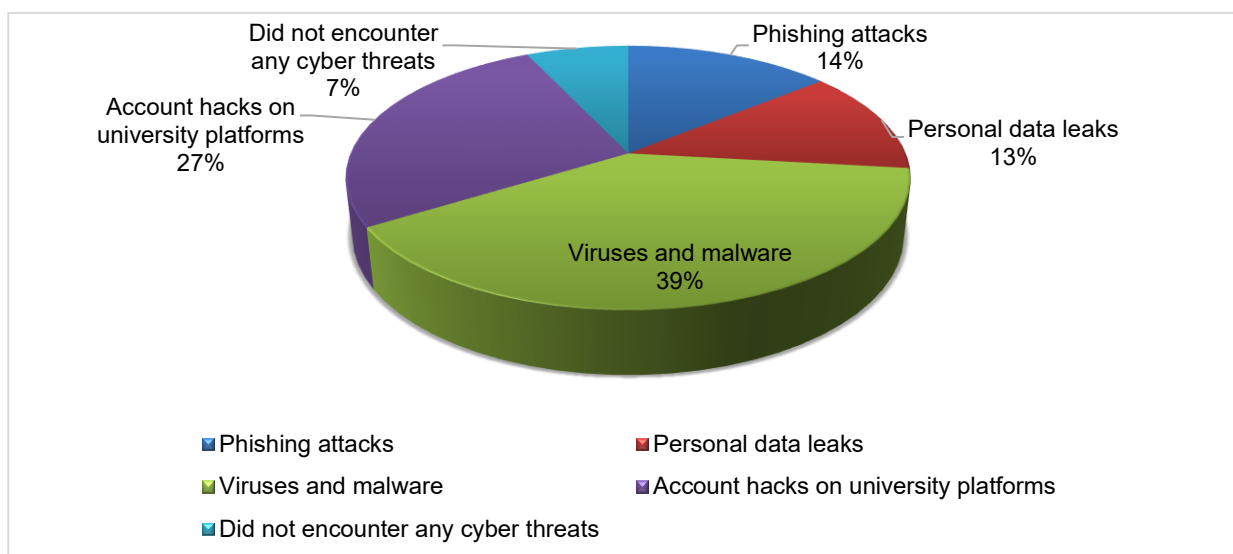


Figure 1. Diagram of the leading cyber threats in Ukrainian universities.

Source: Author's development

The main features of cyberattacks are external manifestation, distance, speed of the crime, specificity of violation of essential characteristics, technological efficiency, automation, the expected result and the degree of complexity of the problem.

The average frequency of cyber threats (on a scale from 1 to 5) is 2.4. This generally indicates that most respondents rarely or occasionally face cyber threats. In particular, 31% face cyber threats once a year.

At the same time, 28.2% faced them 1-2 times a year (rarely). Quarterly or every few months - 21.1%. Monthly - 12.7%. Only 7% encounter it all the time while studying or teaching.

Figure 2 shows the % distribution of the frequency of cyber threats in higher education institutions in Ukraine.

To protect information from unwanted interference, cybersecurity measures should be implemented, which are understood as systemic actions of a technological, organisational and legal nature aimed at targeted detection and elimination of threats to the digital learning space. Ensuring cybersecurity requires the introduction of innovative technologies and a systematic approach. Coordinated actions at the regulatory, state and personal levels also play an essential role.

In addition, it is also worth paying attention to international assistance as a separate response to aggression in cyberspace. This is especially important if it is related to hybrid warfare.

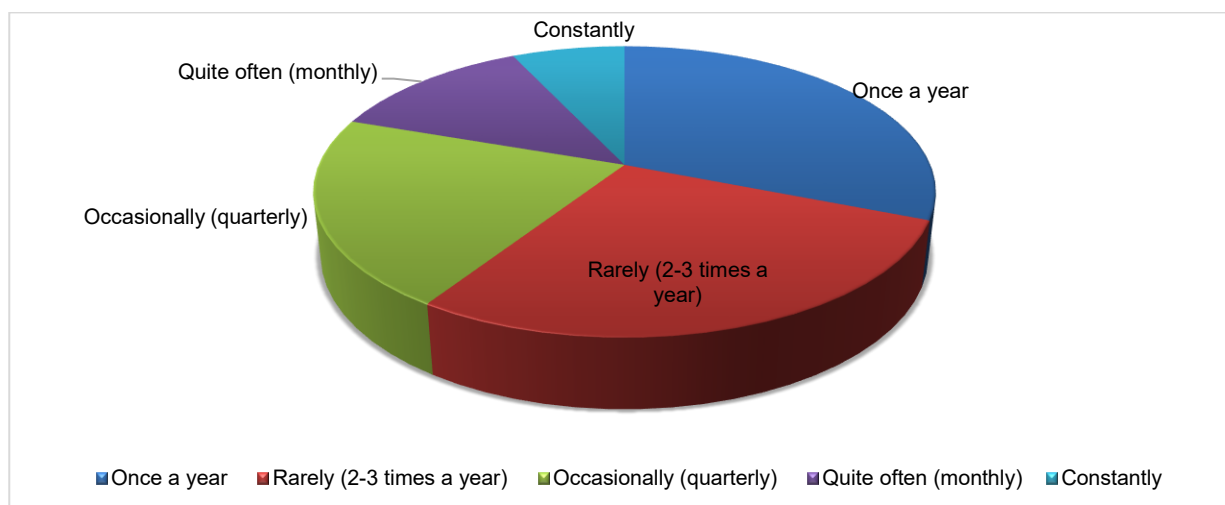


Figure 2. Frequency of cyber threats.

Source: Author's development

Necessary response measures include awareness of all participants in the educational process and developing and periodically adjusting a plan to combat cyberattacks. At the same time, 49.3% of respondents indicated that they are moderately aware of cybersecurity measures at the university. At the same time, 28.2% are poorly aware.

This shows an insufficient level of cybersecurity policy in Ukrainian educational institutions. On the Likert scale, 12.7 and 4.2% of respondents indicated 4 and 5 points.

Table 3 provides detailed data on the participants' responses.

Table 3.

Awareness of cybersecurity basics among survey participants.

Score	Description	N	N %
1	Not knowledgeable at all	4	5,6%
2	Weak understanding	20	28,2%
3	Intermediate level	35	49,3%
4	Well-informed	9	12,7%
5	Very high level of awareness	3	4,2%

Source: Author's development

Combating modern cyber threats in the educational process is essential to ensuring the safety and effectiveness of learning in today's digital environment. The constant and active use of technology in education creates new challenges that require coordinated action to prevent cyber threats.

In particular, Ukraine is currently implementing measures such as developing multi-level protection systems, controlling the Internet, and training students and teachers in the basics of cybersecurity. However, it is imperative to introduce clear restrictions on access to dangerous sites or resources on the Internet, including in educational institutions, and to use software to monitor users' online activities. This will help prevent students from having access to harmful or inappropriate materials.

Data confidentiality is also essential (Newhouse et al., 2017). In particular, teachers and administrators of educational institutions should constantly monitor the protection of students' data, use appropriate encryption methods, and be aware of the rules for data protection by Ukrainian law.

However, a critical area is the development of an effective cybersecurity policy. In particular, modern higher education institutions should develop clear and effective cybersecurity policies for all participants in the educational process.

These strategies should aim to identify and eliminate threats to the digital learning space quickly. In addition, these policies should describe the rules for using digital and computer technologies, online behaviour and responding to identified cyber threat incidents. However, the survey found that not all universities have an official cybersecurity policy. However, the majority of educational institutions do have an official cybersecurity policy.

In particular, 43 respondents indicated that their university has an official cybersecurity strategy. Another 23 people said they were not aware of such a policy. Another five people noted that their institutions do not have an official cybersecurity strategy or policy.

The next question asked whether participants had received formal cybersecurity or digital competence training. Most of the participants had experience of taking digital literacy courses.

However, 34 people had received formal cybersecurity training. Given the challenges of hybrid warfare, this is a relatively low figure. This indicates a need for a more thorough approach to developing a policy for providing a digital learning space.

Table 4 details the responses of the survey participants.

Table 4.

Definition of cybersecurity policy and status of formal cyber defence training.

Questions	N	%
Does your university have an official cybersecurity policy?		
+ (Yes)	43	30,53%
(No) -	23	16,33%
Unknown	5	3,55%
Have you received formal cybersecurity training?		
+ (Yes)	31	43,66%
(No) -	26	36,62%
I am going to pass shortly	14	19,72%
Have you received formal training in digital literacy?		
+ (Yes)	50	70,42%
(No) -	11	15,49%
I am going to pass shortly	10	14,08%

Source: Author's development

The analysis of the responses showed that universities where faculty members participated in digital competency training or received cybersecurity training had significantly fewer cases of cyberattacks.

In addition, professors with high cybersecurity knowledge actively teach students the key basics of online protection. This also reduces the risk of incidents. All participants in the educational process rated the effectiveness of cybersecurity measures at universities at 4 points.

Figure 3 shows the participants' assessments of the effectiveness of cybersecurity measures. In addition, most participants acknowledged feeling secure when using university digital resources (average score of 3 and 5) (see Figure 3).

Integrating two-factor authentication for students and teachers is a promising area for further development of cyberspace. Most respondents emphasised the importance of strengthening authentication at all levels of access to university digital platforms.

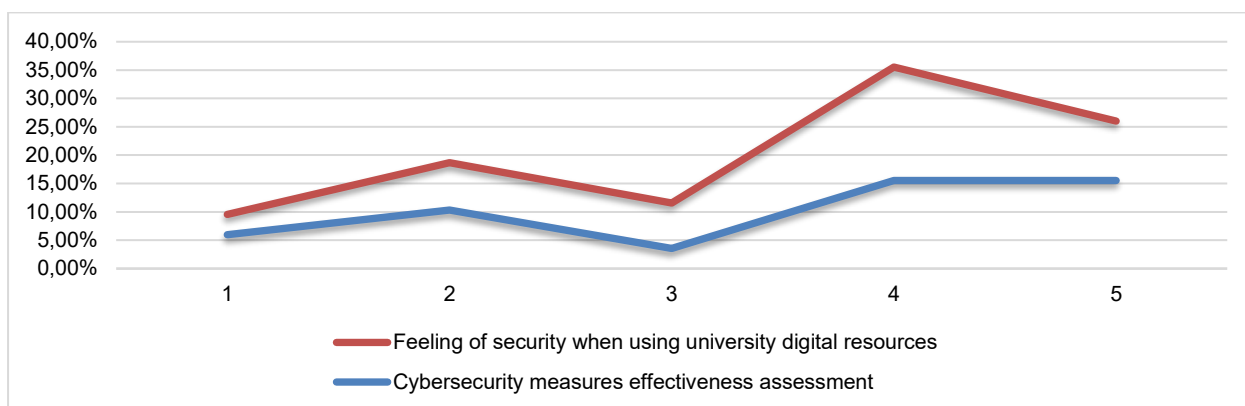


Figure 3. Assessment of the level of cybersecurity at the university.

Source: Author's development

Thus, introducing two-factor authentication will reduce the risk of unauthorised access. It is also essential to audit access to information systems. Monitoring all user actions on the university's digital platforms will affect the timely detection of suspicious activities and ensure a quick response to threats. On the other hand, ensuring data backup and recovery is also essential.

According to the respondents, it is necessary to have a reliable backup system to save important data. For this reason, automatic backups are crucial. In addition, ensuring it is protected from encryption in case of ransomware attacks is a key measure.

However, a significant measure is regular cybersecurity training. It is also worth conducting phishing tests to help raise awareness of the leading cyber threats and mechanisms for detecting and responding to them among all participants in the educational process.

Discussion

Modern digital challenges require timely and thorough responses. Threats in cyberspace pose a serious problem for the functioning of higher education. This is especially true for Ukraine, where the risks of cyberattacks are incredibly high because of Russian armed aggression.

Therefore, the purpose of the proposed study is to analyse the impact of cybersecurity on higher education in Ukraine, identify key threats, and formulate key recommendations for improving the security of educational institutions. This task has involved finding answers to questions about the most widespread cyber threats in the higher education system, determining participants' level of awareness in the educational process to ensure adequate digital space, and finding recommendations for improving cybersecurity in higher education.

Additionally, the goal has been to confirm that cyber threats are much lower in modern colleges and universities that use systemic cybersecurity measures like multi-level authentication and regular system updates and that teachers and students better at using technology are less likely to be attacked online.

The proposed results show that digital technologies have increased dramatically in the Ukrainian higher education system in recent years. Accordingly, only 7% of respondents have not faced cyber threats while studying or teaching. The most common cybersecurity threat is viruses and malware (identified by 39.4%).

Hacking of university platform accounts (26.8%), phishing (14.1%), and personal information leakage (12.7%) are also common.

At the same time, most respondents rarely face cyber threats, with only 7% experiencing them constantly during their studies or teaching. The findings confirm the conclusions of other researchers regarding the extent to which digital technologies (and thus digital dangers) are integrated into modern higher education.

Other researchers believe that hacking personal student accounts is more widespread and is associated with students' low digital competence.

However, such data is not supported by empirical measurements or statistics (Bannikov et al., 2022; Cabaj et al., 2018; Muktiarni et al., 2019). Accordingly, it is difficult to support this position, as many researchers consider viruses and other malware the most significant threat. Researchers also agree that permanent cyber threats are rare.

Therefore, students behave quite cautiously in the digital environment, which does not create additional threats to their learning. Accordingly, scientists believe this reduces the workload of the technical staff of educational institutions (Crick et al., 2019). This allows us to confirm the hypothesis that the higher the level of digital competence of teachers and students, the lower the risk of cyberattacks on university learning systems.

The proposed results also show that to protect information from unwanted interference, cybersecurity measures should be implemented, which are understood as systemic actions of a technological, organisational, and legal nature aimed at targeted identification and elimination of threats to the digital learning space.

Ensuring cybersecurity requires the introduction of innovative technologies and a systematic approach. Coordinated actions at the regulatory, governmental, and personal levels also play an essential role. In addition, international assistance should also be considered as a separate response to aggression in cyberspace. At the same time, 49.3% of respondents indicated that they were moderately aware of cybersecurity measures at the university, and only 28.2% were poorly aware.

This shows an insufficient level of cybersecurity policy in Ukrainian educational institutions. This is comparable to the findings of other researchers who have dealt with this issue (Pozharytskyi et al., 2022). Other researchers who studied students' awareness of countering cyber threats concluded that the overall average indicators in this area are high (Catota et al., 2019; Politova et al., 2022).

Notably, the survey found that not all universities have an official cybersecurity policy. However, most educational institutions do have a formal cybersecurity policy. 43 people indicated that their university has a formal cybersecurity strategy. However, only 34 people have received formal cybersecurity training. Given the challenges of hybrid warfare, this is a relatively low figure. Existing research generally shows that implementing cybersecurity policies typically increases the level of countering threats (Ricci et al., 2018; Rodinova et al., 2024).

This significantly reduces the risk of information leakage, data breaches, etc. In the Ukrainian context, such approaches are only being implemented. At the same time, this allows us to confirm the hypothesis that modern higher education institutions that implement systemic cybersecurity measures have a much lower level of cyber threats. For a long time, timely software updates have been problematic in the Ukrainian context. However, as demonstrated in the proposed study, such a dependence is indeed observed.

The analysis of the responses showed that universities where teachers participated in digital competence training or received cybersecurity training had significantly fewer cases of cyberattacks. In addition, professors with high cybersecurity knowledge actively teach students the key basics of online protection. This also reduces the risk of incidents. All participants in the educational process rated the effectiveness of cybersecurity measures at universities at 4 points.



The integration of two-factor authentication for students and lecturers is a promising area for further development of cyberspace, as noted by most respondents. On the other hand, ensuring data backup and recovery is also essential (Zhyvko et al., 2020). The respondents' answers show that training staff and students on detecting phishing attacks and other types of social engineering is an essential protection aspect.

The proposed recommendations are supported by the work of other scholars who have drawn attention to the importance of further developing practical cybersecurity tools (Dei et al., 2024; Guo, 2023). Some scholars emphasise the importance of continuous learning, as digital challenges are constantly evolving, along with countermeasures. Accordingly, this observation will require further scientific discussion. Other researchers point to the need to develop digital competencies at a reasonably young age. The results also suggest that both views are relevant and can be incorporated into general recommendations.

The methodology used in the study has certain limitations that should be considered when further using the results. The proposed methodology has been primarily based on conducting a survey and identifying relevant data. It should be borne in mind that the respondents' personal experiences may differ; therefore, their answers may be subjective. In addition, it should be borne in mind that Russian aggression (and the related challenge of hybrid warfare) has not been experienced in other European countries. Therefore, specific provisions in the responses may indicate a real military impact on the functioning of digital security in wartime.

Conclusions

Consequently, the most common threats to a secure digital learning space are viruses and malware, hacking of university platform accounts, phishing attacks, and personal data leakage. The surveyed participants in the educational process have an average awareness of ensuring an adequate digital space, indicating the need to improve cybersecurity protection policies.

The respondents' answers pointed to the importance of optimising the cybersecurity space by integrating a two-factor authentication system for students and teachers, implementing system audits, more expansive use of automated threat detection systems, and using encryption to protect data. At the same time, the findings showed that training staff and students to detect phishing attacks and other types of social engineering is a vital protection aspect. The study proved the need to introduce mandatory digital literacy and cyber awareness training and tests. These measures should be implemented to improve cybersecurity in Ukrainian universities.

This research has also opened up new areas for investigation. In particular, future research should be conducted among teachers and students who have taken digital literacy courses or participated in cyber education seminars. This will allow us to assess the impact of these events on the participants' awareness of the educational process. In addition, future work should characterise the latest cyber defence mechanisms, as digital threats will continue to improve and require appropriate innovative protection.

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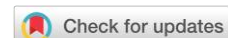


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.4>

Cómo citar:

Nozdrin, O., Dzikovskyi, M., Dzhendzhero, O., Rybalko, A., & Kornienko, P. (2025). Evolution of the right to education concept in general pedagogy and its influence on Ukraine's educational policy. *Revista Eduweb*, 19(2), 53-69. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.4>

Evolution of the right to education concept in general pedagogy and its influence on Ukraine's educational policy

Evolución del concepto de derecho a la educación en la pedagogía general y su influencia en la política educativa de Ucrania

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Recibido: 29/03/25

Aceptado: 21/05/25

Abstract

The article analyses the evolution of the right to education in general pedagogy, taking into account historical, legal and educational transformations. Particular attention is paid to the development of Ukrainian educational policy from 1991 to the present. Using a historical and legal approach, the study covers the analysis of legal acts and key laws in the field of education. The research methods included analysis of legislation, assessment of education policy reforms, and comparison with international standards. The results showed significant progress in the formation of the Ukrainian educational system, its orientation towards European standards, ensuring the right to education in times of war and enhancing the digitalisation of the educational process. The main



conclusions include the transition to the European system of secondary education, the introduction of inclusive programmes, the increased role of higher education and the optimisation of educational institutions. The discussion focuses on the unique challenges that Ukraine faces in ensuring access to education in times of war and overcoming structural policy deficiencies. The study makes a significant contribution to the discourse on the role of legal and pedagogical transformations in shaping equitable and modern educational systems in the global context.

Keywords: right to education, education system, educational authorities, educational reform, international standards.

Resumen

El artículo analiza la evolución del derecho a la educación en la pedagogía general, considerando las transformaciones históricas, jurídicas y educativas. Se presta especial atención al desarrollo de la política educativa ucraniana desde 1991 hasta la actualidad. A través de un enfoque histórico y jurídico, el estudio examina actos jurídicos y leyes clave en el ámbito de la educación. Los métodos de investigación incluyen el análisis de la legislación, la evaluación de reformas de política educativa y la comparación con normas internacionales. Los resultados evidencian avances significativos en el sistema educativo ucraniano, su alineación con normas europeas, la garantía del derecho a la educación en tiempos de guerra y la promoción de la digitalización del proceso educativo. Entre las principales conclusiones figuran la transición al sistema europeo de enseñanza secundaria, la introducción de programas integradores, el fortalecimiento de la educación superior y la optimización de instituciones educativas. El debate destaca los retos específicos que enfrenta Ucrania para garantizar el acceso a la educación durante la guerra y superar deficiencias estructurales. Este estudio contribuye al discurso sobre el impacto de transformaciones jurídicas y pedagógicas en la configuración de sistemas educativos equitativos y modernos en un contexto global.

Palabras clave: derecho a la educación, sistema educativo, autoridades educativas, reforma educativa, normas internacionales.

Introduction

Education, as a fundamental human right, requires comprehensive analysis and evaluation through various historical and societal stages of its development. Since the recognition of education as a human right in the Universal Declaration of Human Rights (United Nations, 1948), the role of educational systems has evolved significantly, becoming an instrument for social integration and economic development. In the context of Ukraine, the research problem focuses on the interplay of historical, political, and cultural factors shaping the modern education system, along with challenges related to implementing innovative methods, digitalisation, and inclusivity.

The growth of education as a fundamental right deserves detailed analysis and scrutiny, taking into consideration different historical and societal stages. This has been a long journey, from the earliest references to schools in ancient Babylon and Greece, where education was only for the few, to today's ideas of education as a fundamental human right. Adopting such a nuanced document as the Universal Declaration of Human Rights in 1948 became a milestone in the history of education, as this document recognised the importance of education in an individual's life in Article 26 (Lorente et al., 2020). In the XX century, with the consolidation of democracy, even greater perceptions were constructed that there was a need to facilitate education for every stratum of society, especially in the era of decolonisation (Ruiz, 2020). As a member of the global movements, Ukraine mirrors this advancement by assimilating international norms within its national legal order. The new world that we live in today calls for the education systems in the countries to be highly developed to enhance fair competition for all the citizens in the country. Education serves the purposes of economic growth and development as well as building the cultural character of people in nations to help them compete globally (Eduardo & Gabriel, 2021). In the framework of international cooperation, the European Union pays considerable attention to harmonising educational standards, contributing to the accessibility and inclusiveness of educational systems (Muskaj et al., 2022).



Ukraine is actively implementing reforms aimed at improving the quality of education, expanding its accessibility and ensuring social integration, focusing on European development models.

The research focuses on the transformation of Ukraine's education system through the integration of international standards and practices, particularly European educational models. Special attention is paid to analysing the role of educators in shaping national identity, incorporating innovative teaching methods such as STEM and digital technologies, and adapting these approaches to national realities. The study also emphasises the challenges of accessibility for vulnerable groups, especially in times of modern crises.

Pedagogical activity has always been the basis for the formation of society, influencing the development of its cultural, social and economic potential. In the historical context, the role of teachers has changed along with social transformations: from the traditional role of teachers as carriers of knowledge to active participants in the process of socialisation and critical thinking. In Ukraine, as in many other countries, teaching laid the foundation for national identity and contributed to the strengthening of culture and language preservation. During the Soviet period, the educational system was shaped by an ideology that limited pedagogical freedom and created barriers to innovation. Nevertheless, since the country became sovereign in 1991, the focus of the pedagogical process has altered to the orientation towards the rather modern methods, building up a new education system that is democratic and adopting global norms. Ukrainian educators were again able to put into practice their concepts about making scholars independent and self-actualised personalities. This liberation, moreover the plenty of reforms that resonated more in the 2000s, has contributed to the existing state of the education system and, in the majority of cases, enhancement of learning inclusiveness, digitalisation and innovation activities in teaching.

The digitalization of education is becoming a central element in the redefinition of education purposefully meant to ease access to knowledge. Introducing information and communication technologies (ICTs) considerably expands the learning possibilities, particularly for disadvantaged groups. The COVID-19 crisis, on one hand, was a successful deployment of distance education but on the opposite — raised the issue of the level of accessibility to digital means (Lorente et al., 2020). In Ukraine, as in many countries, various projects oriented toward education digitization were adopted, such as the development of online educational services and interactive tools that help to reach even the most distant populations (Herawati & Ermakov, 2022). The formation of the Ukrainian education system is closely linked to historical, political and cultural processes that determined its specificity at different stages. During the Kyivan Rus period, the first schools were established based on church centres, focusing on spiritual education. Later, especially when Ukraine was under the influence of Poland, Lithuania and Austria-Hungary, the educational system began to integrate elements of Western European pedagogy. This synthesis significantly expanded the horizons of education while preserving national traditions. In the nineteenth century, under the influence of the Russian Empire, Ukrainian education was Russified, but at that time, the foundations of identity-oriented pedagogy began to take shape. After Ukraine declared independence, the educational system began actively integrating into the European educational space, implementing the Bologna Process in higher education and adapting national education to international standards. Cooperation with the EU countries, which supported Ukraine financially and methodologically, helped reform school education, create inclusive environments and introduce modern teaching methods, became vital.

The latest methods in pedagogy help to improve the educational process, taking into account the needs of modern society. The spread of interactive approaches, such as the flipped classroom, project-based learning models, and the introduction of STEM education, is changing the traditional learning paradigm. These approaches allow pupils and students to participate actively in the educational process, develop critical thinking skills, and make independent decisions (Yen & Hoang, 2022). The Ukrainian education system is actively integrating these innovations, adapting them to national realities and enriching them with its practices through the support of philosophical education and democratic learning models (Butchenko et al., 2022).



To identify the critical features of the transformation of Ukraine's education system, evaluate the effectiveness of modern pedagogical approaches, and provide recommendations to enhance inclusivity and digitalization in educational processes.

1. How have historical and political contexts influenced modern Ukrainian education?
2. How are modern innovative approaches, such as STEM and digital technologies, integrated into Ukraine's education system?
3. What are the main challenges to inclusivity and accessibility in Ukrainian education, and how can they be addressed?

Currently, there is a lack of research on adapting innovative pedagogical approaches within the Ukrainian education system, considering its national cultural characteristics and historical prerequisites. This study aims to bridge this gap by analyzing modern teaching methods, digitalization, and inclusivity while providing recommendations for their effective implementation within the Ukrainian context.

This study consists of several parts. The first part presents the theoretical framework of the research and provides a literature review, with particular emphasis on the analysis of contemporary works related to the right to education in the international context. The following section presents the main findings concerning the development of the right to education in modern pedagogy and their impact on the Ukrainian education system. This part also includes a discussion of the obtained data in comparison with the work of other scholars. In the conclusion, the findings are summarized, and it is noted that this research makes a significant contribution to the discourse on the role of legal and pedagogical transformations in shaping equitable education.

Literature Review

The evolution of the right to education reflects key socio-economic and political transformations in the global context. For example, research on the legal mechanisms for ensuring the right to education through the decisions of the Constitutional Court in Indonesia highlights the importance of judicial systems in addressing issues of access to education (Subawa & Hermanto, 2023). Similarly, as demonstrated by the analysis in Myanmar, legal education in transitional societies is an important factor in democratising the education system (Eberbach, 2023). At the same time, Ukraine is considering challenges regarding ensuring the right to education during the war and integration into European Union standards (Kovtunets & Shevtsov, 2022). These kinds of research exemplify the importance of looking at the aspects of the intellectual mechanism of educational processes governance on the universal levels. The influence of COVID-19 on the education-related rights of people who are at risk is profound. For instance, during the COVID crisis in the UK, one of the provisions of the legislation concerned the extent to which education could be made accessible to children perceived as having challenging behaviour, further entrenched (Ferguson, 2021; (Barrientos Delgado et al., 2021).

In contrast, focusing on the oppressive measures adopted in Malaysia towards facilitating children's right to education during the quarantine highlights the need for reformist efforts to enhance traditional educational systems (Rahman et al., 2023). A similar research gap exists in the provision of education for girls in Tanzania, strengthening the argument for the need for an integrated model of inclusive education (Iddy, 2021). In Ukraine, the issues of inclusive education, especially in times of war, need to be backed by additional legislative measures (Shevchuk et al., 2020). Migration trends are also crucial when enforcing the right to education. Within the European Union, the schooling of immigrant pupils has been analysed from the perspective of educational strategies concerning these groups of children (Neubauer, 2023a; Neubauer, 2023b). In the case of Indonesian Rohingya children, the right to education was frequently inhibited by social and cultural factors (Rumiarta & Jayantiari, 2023). In Ukraine, the efforts to provide children, especially those affected by war, with education often include repurposing resources, which is



crucial (Tomlyak, 2023). Research demonstrates the need to develop adaptive mechanisms to ensure inclusivity in global education systems (Muskaj et al., 2022; Flores Giménez, 2023).

The digitalisation of education is one of the key topics in contemporary educational research. Machado and Pereira (2023) examine the impact of digital tools on assessment in higher education. UNESCO's role in promoting accessibility to higher education through digitalisation is an important step towards integrating new technologies into the learning process (Lázaro Lorente, 2022). The use of digital tools to develop democratic competencies in sports pedagogy demonstrates the interdisciplinary potential of such approaches (Žnidarec Čučković, 2022). In Ukraine, strategic digital initiatives during the war became key to ensuring the continuity of the educational process (Romanova, 2023; Matsheta & Sefoka, 2023).

The significant emphasis on the introduction of e-assessment in the higher education system described by Shalatska et al. (2020) indicates a shift towards more integrated digital technologies that contribute to the modernisation of educational processes. Comparison with the European experience presented by Saienko et al. (2023) demonstrates Ukraine's orientation towards adapting educational trends of the information society, emphasising the role of technical innovations in shaping modern educational policy.

Inclusiveness and social justice in ensuring the right to education are gaining more and more attention in the current literature. In Portugal, for example, adult education is seen as a basis for social mobility (Barros, 2023). In Indonesia, legal provisions for inclusive education are becoming a central element in ensuring the rights of persons with disabilities (Notoprayitno & Jalil, 2019). A global approach to the right to education, as Amin (2023) notes, provides a basis for critical rethinking of educational systems. In Ukraine, the right to education becomes especially important in times of war, when the protection of intellectual property in universities becomes an additional challenge (Osypova, 2021). Inclusive strategies and cross-border synergy are central to understanding the current education policies, as evidenced in many of these works. In different regions of the world, the evolution of the right to education can be viewed as the cornerstone of social development. For instance, in Indonesia, it has been shown how policies that guarantee access to education for all citizens have been affected by constitutional provisions (Subawa & Hermanto, 2023). In contrast, together with other components of social transformation in Myanmar, human rights education anticipates and supports the design of a democracy (Eberbach, 2023).

Owing to the war circumstances, the system of education in Ukraine has also started to embody degree provisions within the law concerning the provision of education in general and especially in regard to that of displaced persons (Kovtunets & Shevtsov, 2022); (Romanova, 2023). In the global context, research demonstrates the importance of legal support for education as a tool for reducing social inequalities and building sustainable societies. Large-scale global crises, such as the COVID-19 pandemic, have had a significant impact on the realisation of the right to education. In Malaysia, quarantine restrictions have sparked discussions about adapting education systems to emergencies (Rahman et al., 2023). In the UK, pandemic measures have affected vulnerable groups such as children with behavioural disorders, highlighting the importance of integrative approaches to educational reforms (Ferguson, 2021). Tanzania's experience combating gender discrimination in education points to gaps between legislative initiatives and their implementation (Iddy, 2021). These examples, complemented by Ukrainian research on inclusive education, emphasise the relevance of developing flexible and adaptive education policies (Shevchuk et al., 2020; Tomlyak, 2023; Wodon, 2023).

Studies of the digitalisation of education broaden the understanding of modern educational transformations. Neubauer (2023a) studies the influence of digital platforms on the educational inclusion of migrants, particularly children, in Europe. In the publications of Lorente & Rodríguez (2023), the arguments are established on the necessity to democratise access to higher education using digital transformations. In turn, deploying digital technologies during the war in Ukraine was a tactical measure to sustain the educational process (Romanova, 2023). It has also been argued in Indonesia that the digitalisation of education has proven to help ensure inclusive learning methods for the disabled (Notoprayitno & Jalil,



2019). Thus, scientific publications uphold the argument that access to education is a social advancement resulting from innovative ways of achieving teaching, digitalisation, and inclusive practices around the world. In response to the war, the education sector of Ukraine seeks to embrace educational reforms by incorporating new strategies that will promote the fair distribution of educational resources. Such educational transformations occur against the backdrop of the universal right to education, fraught with challenges posed by globalisation and rapid socio-economic changes. Therefore, recent academic works address alleviating educational inequities and using technology to support educational systems during emergencies. However, in modern works, the emphasis is mainly on the use of empirical data processing methods. Also, many authors have carried out systematic reviews that have drawn attention to works up to 2020. Accordingly, the main attention should be paid to the analysis of new sources and their critical processing. This study will fill these methodological gaps and carry out a comprehensive theoretical analysis. In addition, there is a lack of works in the scientific space that would analyze the historical development of laws on education and their implementation in Ukraine. Accordingly, this study aims to address this gap and describe the main evolutionary milestones of modern education in Ukraine with a focus on international practices.

Methodology

Type of Research

The research presented is evaluative and organised into coherent sections offering a thorough historical, present-day and prospective study of the issue of the right to education in the universal aspect and its influence on the education of Ukraine. The main goal was to study structural changes in the Ukrainian education system under the influence of historical, social and political factors, focusing on the challenges and transformations caused by the war in 2022. The research covered international aspects of the evolution of the right to education and their adaptation in Ukraine, including digitalisation, inclusion, and school and higher education reforms. The analysis made it possible to assess the level of compliance of Ukrainian educational reforms with international standards and identify potential gaps in integrating modern pedagogical practices in distance learning and ensuring the right to education in times of crisis. The article highlights the scientific understanding of the transformation of education in the context of global challenges and forms the basis for further research in this area.

Research data

The study was based exclusively on secondary data collected from official sources of the Ministry of Education and Science of Ukraine, state statistics portals, regulations, reports of international organisations (UNESCO, World Bank, European Commission) and scientific publications covering 2017-2024.

Secondary data was used to study the following aspects:

1. The evolution of international standards in the field of the right to education influenced the reform of the education system in Ukraine.
2. Study the educational changes occurring across different European countries and their relation to the case of Ukraine.
3. Study the transformations in educational infrastructures, inclusive education technologies, and digitalization strategies during the war.

Methods of collecting secondary data

The main sources of data were:

- Regulatory documents of Ukraine: The Laws of Ukraine "On Education" (Law No. 2145-VIII, 2017), as well as numerous bylaws and recommendations of the Ministry of Education
- Statistical data published by the State Statistics Service of Ukraine, including the distribution of education expenditures and the number of pupils and students in different categories of educational institutions.
- International reports covering global trends in the right to education, digitalisation and inclusion.
- Analytical materials published by scholars and international organisations on education transformation during the war.

The inclusion of these sources was based on a strict selection criteria. In particular, the criteria were as follows:

1. Time range from 2017-2024
2. Geographical range: EU countries, Ukraine.
3. The study should present the following aspects:
 - The impact of historical changes on the Ukrainian education system
 - The results of education reform in the context of European integration
 - An analysis of wartime challenges
4. Methodological value: a clear text about the instruments and methods used is presented

Therefore, to ensure the rigor of the study, explicit criteria were established for the selection, evaluation, and systematization of documentary sources. First, official documents issued by recognized national and international organizations (the Ministry of Education of Ukraine, UNESCO, the European Union, among others) were prioritized, as well as peer-reviewed scientific articles published between 2017 and 2023. The sources were evaluated based on their relevance, thematic relevance, institutional validity, and analytical contribution to the object of study.

Data analysis

The analysis process was carried out in three phases:

- 1) Identification and thematic classification of documents according to previously defined analytical categories (right to education, inclusion, digitalization, educational legislation, war context);
- 2) Application of content analysis to identify trends, convergences, and contradictions between sources;
- 3) Comparison of national regulatory frameworks with international standards to assess the degree of alignment and adaptation.

Secondary data were processed and analysed using content analysis and comparative analysis. Data was systematized using a thematic analysis matrix developed in Excel, which ensured the traceability, transparency, and replicability of the research process.

This method allowed us to identify the main trends in the evolution of educational rights and their integration into Ukrainian legislation. Comparative analysis helped to identify the relationship between international standards of the right to education and their implementation in Ukraine, especially in times of war. Particular attention was paid to:

Systematising changes in legislation, including a focus on patriotic education, digitalisation and inclusion. Assessing the impact of the war on access to education and the destruction of educational infrastructure. Analysing statistical data on education spending that reflects government priorities during the crisis.

The data were processed using Microsoft Excel software to create tables and graphs showing key indicators such as education expenditure, access to education for different social groups, and the pace of digitalisation.

Limitations of the study

The study has several limitations. First, it is based solely on secondary data, which may reduce the possibility of taking into account specific local aspects not covered in existing sources. Second, due to the dynamic nature of events in Ukraine, some of the data may become obsolete in the event of changes in legislation or policy. Third, the data was limited to official sources and reports, which affected the scope of the analysis.

Results and Discussion

The evolution of law as a system of rules governing social relations can be traced back through centuries of human history, reflecting the specifics of cultures, social conditions and political institutions. One of the earliest examples of a legal system is the Hammurabi Codes in Mesopotamia (around the 18th century BC), which established the foundations of legislation and the principle of proportionality of punishment. In the Middle Ages, religious law, such as sharia or canon law, played an important role in shaping the norms of social life. Gradual secularisation in Europe in the eighteenth and nineteenth centuries, due to the influence of Enlightenment ideas, helped to consolidate the concept of natural rights and freedoms, enshrined in documents such as the Declaration of the Rights of Man and of the Citizen (Elysee, 2022). In the twentieth century, the efforts of international organisations such as the United Nations led to the creation of universal human rights standards, such as the Universal Declaration of Human Rights (United Nations, 1948), which ensured the global unification of legal norms. The evolution of law continues in the modern world, shaping new approaches to the protection of rights in the context of digitalisation, globalisation and climate change. The chronological sequence of the evolution of the right to education is shown in Table 1.

Table 1.

Chronological evolution of the right to education: stages and their characteristics

Stage	Chronological sequence	Characteristics of the stage
Antique period	VI century BC - V century AD.	Education as a privilege of the elite. The main ideas belonged to Plato and Aristotle, who focused on the development of a virtuous citizen. Education was limited to men of free status.
Middle Ages	V-XV centuries.	Education became religiously oriented, concentrated in monasteries and cathedrals. The main emphasis was on spiritual education. Education was available only to a narrow circle: the clergy and aristocracy.
The Renaissance	XV-XVI centuries.	Revival of interest in ancient culture and science. Education becomes more accessible to the laity. Humanist ideas such as individual human development (Erasmus of Rotterdam, Vittorino da Feltre) emerge.
Education	XVII-XVIII centuries.	Education is perceived as the key to society's development. Thanks to thinkers such as Jean-Jacques Rousseau and John Locke, the idea of equality in education is spreading. The concept of state participation in ensuring the right to education is introduced.
The revolutionary period	XVIII-XIX centuries.	Education has become compulsory in many countries (Prussia, France). The idea of universal access to education emerges, and primary education is made compulsory for children, regardless of social status.
The industrial period	XIX - early XX centuries.	The idea of mass education spreads, especially in connection with the needs of industrialisation. Vocational schools emergence. Education becomes a tool for training the workforce.
The modern period	XX - XXI centuries.	Enshrining the right to education in international documents (in particular, the Universal Declaration of Human Rights, 1948). Emphasis on inclusion, gender equality, and access to quality education for all population segments. Digitalisation of education.

The historical development of education reflects the multifaceted evolution of human civilisation, transforming its meaning from the transmission of basic skills to the formation of an innovative and competent society. In ancient cultures, such as Egypt, Sumerian, and India, education was sacred, focusing on teaching religious dogma, writing, and mathematics to a narrow circle of elites. Medieval Europe promoted education through monastic schools and universities, which became the basis for transferring knowledge in theology, law, and medicine. The industrialisation of the 18th and 19th centuries changed the approach to education, consolidating the idea of universal secondary education, which was enshrined in the laws of Prussia and France. The modern era is shaping new approaches, focusing educational systems on sustainable development, digitalisation and inclusiveness, which requires responses to the challenges of globalisation, migration and technological progress.

In contemporary society, education takes on the role of a social escalator and a way of innovative advancement, which is of great importance in forming a sustainable future. Ukrainian education is an ancient system based on the customs of many peoples and epochs. The first evidence of a school system in Ukraine is known from historical accounts of Kyivan Rus, which adopted мур schools run by monks and cathedrals, such as that of Saint Sophia in Kyiv. This was a facilitating factor towards education development as Ukrainian lands became attached to the Grand Duchy of Lithuania and Polish-Lithuania and incorporated from the activities of fraternal schools in the 15th-17th centuries, which integrated the national and Western European education systems. Under the Russian and Austro-Hungarian empires, Ukrainian education maintained distinctly autonomous aspects – for example, the presence of Lviv University or the Kyiv-Mohyla Academy. From the mid-twentieth century onwards, Soviet Ukraine underwent a process of standardization of education that was characteristic of the entire USSR, focusing on technical education, universal flooding of education and ideological training. After the declaration of independence in 1991, Ukraine made its education system incompatible with the existing system in the European countries. It joined the Bologna Process and enacted the new Law of Ukraine “On Education, which laid the foundation for subsequent reforms (Law No. 2145-VIII, 2017). Education in Ukraine has always coexisted with local and transnational forces and has sought to maintain its uniqueness while aspiring to become part of the global education system.

Ukraine has been on the right path to reforming education since it became an independent country in 1991, looking specifically for ways to improve standards at European levels and provide quality education for everyone. Moreover, in 2017, a new Law on Education was passed where the New Ukrainian School (NUS) paradigm was described where instruction is anchored on competencias (Law No. 2145-VIII, 2017). The Bologna process was also acceded to in 2005, and this facilitated the Ukrainian higher education system's full compliance with the European system of higher education and the adoption of the ECTS grading system.

Other important initiatives include introducing external independent testing (EIT) in 2008, which significantly increased the transparency and accessibility of higher education. In 2020, the COVID-19 pandemic triggered a large-scale shift to distance learning, which revealed both a significant digital divide in access to education and the need to modernise schools' technical bases.

The full-scale war launched by Russia in 2022 has radically changed the Ukrainian education system, posing numerous challenges. Security issues, mass migration of students and teachers, and the destruction of schools (3,793 damaged and 365 destroyed) have made access to education more difficult, especially in the frontline and occupied regions (Bobro, 2024). The Constitution of Ukraine continues to guarantee the right to education even in times of crisis, and government policy has focused on maintaining accessibility and quality of education. Changes have also affected higher education, with numerous universities relocated and mergers becoming a key optimisation strategy. Legislative initiatives focused on university autonomy, quality training and international cooperation. Given the military mobilisation, students, postgraduates, and teachers are still granted a deferment from service, which is an important mechanism supporting educational institutions' functioning. At the same time, the role of education in



patriotic education is being strengthened through updated programmes such as Defence of Ukraine, which cover first aid, tactical medicine and drone control skills (Ministry of Education and Science of Ukraine, 2023). Ukraine has many higher education universities, allowing everyone to receive a quality education, as shown in more detail in Figure 1.

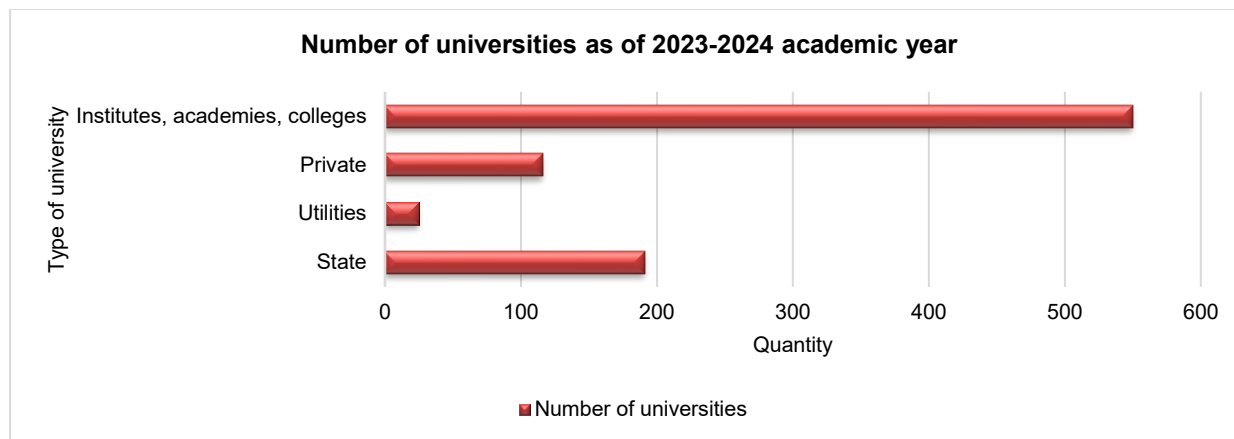


Figure 1. Distribution of higher education institutions in Ukraine in the academic year 2023-2024
Source: Ministry of Education and Science of Ukraine (2023)

Beyond 2023, Ukraine is actively introducing digital technologies into the education system to ensure access to education in times of war and reconstruction. The Mriya educational app has become an important step in digitalisation, offering students and teachers tools for interactive learning, assessment and feedback. In 2023, a new educational ombudsman service was launched to protect the rights of students, teachers and parents and to strengthen social support for participants in the educational process. The reform plan for 2024-2025 includes strengthening inclusion, developing programmes for children with special educational needs, and upgrading infrastructure by constructing school shelters. Significant changes are planned for school curricula: expanding the digital component, integrating artificial intelligence, and updating civic and national-patriotic education courses. In the higher education sector, the emphasis is on grant funding for students, modernisation of research programmes and increased academic mobility, shaping a new paradigm for Ukrainian education as part of the global education space.

The importance of education in Ukraine's current policy is underscored by the significant increase in budgetary spending on this sector, even under martial law. In 2024, education received approximately 20% of the country's total budget, demonstrating the significance of this area in terms of national security, cultural growth, and citizenship. The war destroyed the educational facilities, rendering the need for the inclusive resolution of the Ukrainian cultural space via education. Initiatives on patriotism, recent changes to school syllabus, and incorporation of national history and language courses point to the importance of education in maintaining one's identity. On the other hand, the funds allocated to the programs aimed at rehabilitating educational facilities with such focus on reconstructing and repairing shelters, buying e-resources and providing technological gadgets for learners show the value of education even in circumstances of emergency.

Table 2.*Consolidated budget expenditures on education in 2022-2023 (by level of education)*

Direction	Expenditures, actual 2022, UAH billion	Number of students, 2022, people	Per applicant, 2022, UAH	Expenses, plan 2023, UAH billion	Number of students, 2023, people	Per applicant, 2023, UAH
Pre-school education	40,7	1 111 358	36 629,53	51,4	739 722	69 550,45
General secondary education	145,3	4 230 358	34 346,84	145,1	4 041 976	35 898,28
Professional (vocational) education	15,5	243 825	63 571,73	17,3	230 474	75 049,68
Professional higher education	14,9	362 485	41 059,15	15,5	331 488	45 747,66
Higher education	40,9	973 205	47 116,50	45,2	973 020	46 433,02
Extracurricular education and out-of-school activities for children	13,0	980 789	13 208,17	14,5	1 011 403	14 361,04

Source: Ministry of Education and Science of Ukraine (2023)

The process of including Ukraine in the common European educational area has enshrined the primary vector of educational policy development directions after signing the Association agreement with the EU in 2014. Reforms are being implemented with the European partners to ensure that Ukrainian education corresponds to the Bologna Process. Some legislative changes, such as the Doctrine of National Education Development, 2016, Law on Education, 2017, Law on Complete General Secondary Education, 2020, etc., which underpin the introduction of competency-based education, are meant to enhance the quality of education and the movement of the students and teachers as well. Everything possible has been done to educate everyone, especially vulnerable ones, including internally displaced persons and those with special educational needs. In primary education, the implementation of the New Ukrainian School has become a bright example of innovative changes in education, as in higher education, there has been an increase in the issuance of grants and partnerships with top European UCs. The shifting paradigm of understanding the right to education significantly impacts the shaping of the present-day education policy in Ukraine, primarily relating to its contemporary global context. With the Polish, German, and Finnish experience, as well as in many other European countries, Ukraine's education has begun to embrace equality, accessibility, and innovation as stipulated in the European education norms. The use of digital resources, implementation of inclusive strategies, and development of comprehensive curricular reforms are indicators of the transformation of education from a basic right to education as a fundamental human right to a means of social transformation. As part of that process, Ukraine participates in various projects, such as the Erasmus+ programme. The subject matter of the research contained the study of historical delineation, contemporary issues, and implications within Ukraine for a relevant topic: the evolution of the right to education. The objective was to study whether Ukraine's education system could withstand the existing conflict and crisis. Results indicated that the significant forces of change stemmed from global developments and local factors, including wars or other disasters, and the advancement of information technology in education. These results correspond with the findings of other researchers that state the great necessity of ensuring the right to education in times of crisis for the country's social cohesion (Llona et al., 2023; Barrientos Delgado et al., 2021; Amin, 2023). There is correspondence and divergence with the analysis results in the body of literature. The studies of the functioning of educational systems in the context of COVID-19 also include global challenges, for example, access-related inequalities or digital divides (Czerepaniak-Walczak, 2020);



Kryvenko, 2023). Ukraine's digitally active strategies correspond with the world's strategies and have, however, been hampered by the prevalence of war. In the case of war, unlike previously during the pandemic, the policy pursued by Ukraine centres on tackling the problem of student displacement and restoring the available infrastructure (Van Esveld, 2023; Zancajo & Valiente, 2019; Zayukov et al., 2024). The results of the study showed progress in the education authorities of Ukraine; the use of information technologies has improved, participation has increased, and there has been an improvement in the role of education towards the promotion of human rights. Even with the destructive regularity of warfare as experienced in Ukraine, the growing effectiveness of educational institutions lifts the necessity for specific innovations, especially those provided by educational technology systems such as online learning platforms.

However, issues remain, such as ensuring fairness for displaced students and connecting the isolated regions. These remarks strengthen the ongoing discourse about the need to revise the right to education in a globalizing world, as proposed by (Beiter, 2023; Sheppard, 2022; Ulfat, 2023; Munongi, 2023). The research underlined some aspects of the education systems studied that remained unexamined. Analysis was limited only to the secondary sources concerning conflicts and provided no direct input from the students and the teachers in the conflict zone. The narrow scope of the research, which is on Ukraine, makes it impossible to extrapolate findings to other contexts.

In the same way, they do not impair the study's value about the comprehension of the endurance of education systems in extreme situations (Ducarre, 2023; Flores Giménez, 2023; Wodon, 2023). The study's outcomes reveal the degree of local and global influences on the right to education development in Ukraine, similar to some processes observed in other countries. This is consistent with the work of Sverdllick (2019), who argues that in times of crisis, inclusion becomes a paramount aspect of the right to education. Simultaneously, while ASEAN counterparts addressed similar concerns during the pandemic Juwita (2020), the education policy of Ukraine pursues more digitalisation and physical infrastructure reconstruction, which is quite the opposite. Alternatively, using educational technologies such as the Mriya application for education lessens the differential access to education, according to Rakhimov and Mukhamediev (2022).

The high degree of focus on e-education that was analysed in this study is in line with the digitalisation of the educational process, which, as noted by Sydorenko (2024), aims at fostering communication competencies of learners irrespective of their age as part of the so-called lifelong learning, through the use of training techniques based on interactions. Uniquely in the case of Ukraine, online psychological testing has been implemented (Reva & Demchenko, 2024), a crisis intervention tool that also serves to individualise the educational experience. Compared to the findings of Nagro et al. (2022), who analysed legislative initiatives in the United States, the Ukrainian approach shows less dependence on court decisions but a greater focus on practical reforms and innovations. The integration of international approaches into Ukrainian education confirms the universality of certain principles, such as openness and accessibility. The study by Katsouda et al. (2024) emphasises the role of openness in ensuring accessibility of education through virtual platforms, which resonates with Ukrainian initiatives in the field of distance learning. However, the uniqueness of the Ukrainian experience during the war lies in strengthening national and patriotic education, which guarantees the preservation of cultural identity even in crisis conditions. Similar to Chile (Sánchez-Mendiola et al., 2023), Ukraine uses digital platforms to ensure the quality of education, but with a focus on local specifics.

The addition of nationalistic subjects in the curriculum, including components like "Defence of Ukraine," is determined by national interests absent in other legislation. Apart from that, the current research findings indicate the usefulness of international assistance for the education system in crisis, which is consistent with Van Esveld's (2023) suggestion of delivering education to all internal refugees and their children. Ukraine illustrates how its internal reforms can move quickly along with integrating international norms and principles. The research outcomes underline the need for a philosophical stance towards the legal dimension of education. The advancement of the regulatory processes in the constitution-making drafter



in Ukraine pertains to the concept given by Prodan (2023), who refused to separate the culture of education from its place in a mat constitutional framework. However, the Ukrainian case draws attention to the concern of educational policy due to the regional challenges faced. Findings agree with Rodinova et al. (2024), who indicate exploring the Politics of Digital Branding in Education and the Economy: Risks and Opportunities.

The distinctiveness of the Ukrainian experience is manifested in the implementation of inclusion at the time of active military hostilities, which also correlates with the results related to the provision of education to displaced persons. This is in line with the research findings of Sverdlick (2019), which remark on the challenges of promoting educational inclusion during periods of crisis. Nonetheless, public policy seems to play a bigger part in these countries due to the existence of digital inclusiveness projects in the case of Ukraine. This is most effective, as opposed to the approaches employed in the research by Juwita (2020), in which access to education in the ASEAN region is explained. The measures taken by the Ukrainian administration to pursue the implementation of digital educational tools prove the affinity to the view held by Katsouda et al. (2024) on the philosophy of openness. Our findings support the argument that there is a need to modify norms and practices in the education system for it to operate in conditions of a crisis, as Ramadani et al. (2021) argue while analyzing the educational balance with public health in Indonesia during the COVID-19 rut. In the case of Ukraine, this resulted in accelerating digitalization processes in education, which were actively used in the educational policy during wartime. The disparity, however, exists in the promptness with which the education system of Ukraine has adjusted itself, relatively blending both the physical reorganization of schools and the digitization of schools, which is quite exceptional based on other nations.

Furthermore, the practical aspect of the teaching and psychological assistance projected by Reva and Demchenko (2024) explains the modernisation of the educational system in a way that is consistent with very recent developments in the work of Rakhimov & Mukhamediev (2022). In this regard, this research work's value or scientific contribution is that it explores the global education policy landscape and presents the unique problems that Ukraine encounters. The research contributes to overcoming the existing barriers to understanding education about the dynamics of war to strengthen society by providing a model other countries can adopt. It builds on previous work, emphasising the importance of integrating global criteria and local approaches (Van Esveld, 2023; Barrientos Delgado et al., 2021; Pache et al., 2023; Hélot & Bonacina-Pugh, 2023).

Among the future research prospects is the longitudinal assessment of the effects of education policies and their comparative study with those of other crisis-affected countries. Further exploring the nexus between the digital divide, socio-economic disparities, and education reform would offer practical insights on maintaining a balance in the education system (Llona et al., 2023; Zancajo & Valiente, 2019). This brings about new horizons in studying education as a basic right and an instrument for the development of society.

Conclusions

The objective of research on the development of the concept of the right to education in general pedagogy has been achieved. It also involved consideration of unique features of the Ukrainian educational system through the lens of its historical evolution and wartime crisis. Finally, it assessed how the educational system has been (re)adjusted in these digitalization and globalization times. The primary findings indicated that everyone's right to education has progressed through several transformations, from an entitlement available to few to a universally recognized and codified system. The educational system of Ukraine, even under the circumstances of war, can reconstruct itself in terms of digitalisation, inclusion and integration into the global educational system. It has been found that modern solutions, including digital channels, mobile learning tools, and curricula, enable resources in situations, and access even in unfavourable situations about inclusion and mobility in education remains central to this study and warrants further



exploration. It is concluded that implementing national education systems within the framework of the Bologna Process enhances academic quality and helps develop the mobility of students and academicians. Contrary to these advances, issues such as how exactly the provision of such education via digital means will affect the quality and access of education to disadvantaged populations in the long run still need to be answered. The analysis exhibited that Ukraine's constitutional guarantee of the right to education has been adapted to the wartime crisis. Remarkable advances have already been achieved in extending educational facilities through developing digital resources, which has reduced education losses even in the regions where active conflict operates. Special efforts were made to transform the legislation, guaranteeing equal rights and opportunities in the education process for all, including displaced persons and disabled people. Integration of the national programs with those of the international standards is another milestone, as it serves to uphold and advance education, which the society of Ukraine cherishes as one of its fundamental values, including in times of crisis. A further line of inquiry may consider the effects of digital educational technologies examined over an extended time frame, particularly concerning learning outcomes. In addition, such a comparative analysis could also be conducted by focusing on the education system reforms in other crisis countries, which would facilitate the recognition of successful strategies and their transformation to Ukrainian realities. Investigating these areas will enhance education policy and practice regarding its sustainability and capacity to meet global challenges.

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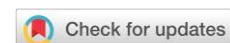


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.5>

Cómo citar:

Boiko, O., Hurskaya, V., Moroz, T., Tron, T.V., & Kozak, V. (2025). Analysis of methods of teaching english as a foreign language using multimedia technologies. *Revista Eduweb*, 19(2), 70-81. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.5>

Analysis of methods of teaching english as a foreign language using multimedia technologies

Análisis de métodos de enseñanza del inglés como lengua extranjera mediante tecnologías multimedia

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Recibido: 29/03/25

Aceptado: 22/05/25

Abstract

This study aims to evaluate the effectiveness of multimedia technologies in teaching English as a foreign language. To achieve this, an experimental study was conducted, involving two groups of students. The control group followed a traditional methodology, while the experimental group was taught using multimedia technologies. The experiment lasted six weeks, allowing for an in-depth comparison of the learning outcomes between the two groups. The findings confirmed that multimedia tools contribute to English



language acquisition by enhancing foreign language competence, fostering creative thinking, and reinforcing professional skills. The integration of multimedia-based approaches elevates the learning process to a qualitatively new level. Interactive multimedia technologies not only enrich educational content but also enable students to learn at their own pace and support personalised instruction. The study also focuses on linguistic and pragmatic methods that influence students' academic self-efficacy. The results suggest that a mixed-methods approach supported by multimedia has a positive impact on students' confidence in their academic performance. The research highlights the necessity of improving multimedia-based programmes to enhance motivation and sociolinguistic awareness among students and teachers.

Keywords: Interactive learning, digital pedagogy, communication strategies, audiovisual support.

Resumen

Este estudio tiene como objetivo evaluar la eficacia de las tecnologías multimedia en la enseñanza del inglés como lengua extranjera. Se llevó a cabo un estudio experimental con dos grupos de estudiantes: uno de control, que siguió un enfoque tradicional, y otro experimental, que utilizó tecnologías multimedia. La duración del experimento fue de seis semanas, lo que permitió comparar los resultados de aprendizaje de ambos grupos. Los hallazgos confirmaron que el uso de herramientas multimedia mejora la competencia en lenguas extranjeras, fomenta el pensamiento creativo y fortalece las habilidades profesionales. La integración de enfoques multimedia eleva el aprendizaje a un nivel superior. Las tecnologías interactivas enriquecen los contenidos educativos, facilitan el aprendizaje autónomo y promueven la instrucción personalizada. Además, el estudio analiza métodos lingüísticos y pragmáticos que influyen en la autoeficacia académica. Los resultados indican que un enfoque de métodos mixtos respaldado por multimedia tiene un efecto positivo en la confianza de los estudiantes en su desempeño. Finalmente, la investigación resalta la importancia de mejorar los programas educativos basados en multimedia para optimizar la motivación y la conciencia sociolingüística de estudiantes y profesores, contribuyendo así a la innovación en la enseñanza del inglés como lengua extranjera.

Palabras clave: Aprendizaje interactivo, pedagogía digital, estrategias de comunicación, apoyo audiovisual.

Introduction

Trends in the new education system of Ukraine define the priority ways of developing education by introducing modern information technologies in the educational process. Transformations in Ukrainian education require a deep restructuring of pedagogical and psychological science by the new realities of modern life (Turchyn et al., 2023). The latest technologies are penetrating deeper into all spheres of human activity; therefore, at the present stage, the informatisation of education is considered a system of processes aimed at meeting the educational, information, computing and telecommunication needs of participants in the educational process (Morozova et al., 2021). In this aspect, multimedia technologies such as interactive platforms, video tutorials, mobile apps and virtual reality create a dynamic learning environment for students. For foreign language learners, integrating multimedia into the curriculum helps to develop all language skills (Xu et al., 2021). Thanks to the capabilities of multimedia technologies, listening, speaking, reading and writing skills are improved. Teachers who implement them in their work ensure individualisation of the learning process and increase student motivation.

Accordingly, the proposed study aims to evaluate the effectiveness of using multimedia technologies in teaching English. The aim of the study guided the following research questions:

1. How does integrating multimedia technologies affect students' progress in learning English?
2. What multimedia tools can be identified as the most effective in acquiring language skills?
3. How do multimedia technologies model student motivation?



The scientific novelty of the study lies in analysing the effectiveness of multimedia technologies in teaching English, taking into account modern educational trends. Also, the novelty and expediency of this work lie in the comprehensive approach to assessing the effectiveness of multimedia. The analysis is made possible by analysing the impact on student's motivation and engagement in the learning process.

The paper is aimed at considering new methods of teaching English and their limitations. A separate issue is the analysis of the implementation of multimedia technologies in new methods of teaching foreign languages. The proposed experimental study's results should help objectively evaluate the effectiveness of multimedia teaching compared to traditional methods and develop recommendations for the use of multimedia technologies in teaching English.

Thus, the purpose of the article is to consider the introduction of multimedia technologies into new methods of teaching foreign languages. The results of the work will be helpful in developing recommendations for the use of multimedia technologies in teaching English. The work follows a logical sequence of structure, which includes a literature review, research methodology, analysis of experimental results and practical recommendations based on the data obtained.

Theoretical Framework or Literature Review

Related research in the field of didactics shows that multimedia technologies are extremely effective for teaching foreign languages. Using interactive platforms, mobile applications, virtual simulations, video tutorials, and artificial intelligence systems, teachers can adapt learning to the needs of each student. Vedadi et al. (2019) emphasise the effectiveness of multimedia learning through the integration of visual and auditory components in English language learning. They contribute to the effective memorisation of the material. In another related study, the authors argue that the use of virtual and augmented reality significantly motivates students by immersing them in a realistic language environment (Abdulrahman et al., 2020). It should also be noted that all new technologies do not replace traditional teaching methods. Rather, they increase their effectiveness. Therefore, the authors do not argue about the relevance of communicative, blended and project-based approaches. According to scientists, new technologies are the most effective today for learning a foreign language. In their work, Isakova et al. (2020) investigated the impact of blended learning and the communicative method in Ukrainian secondary schools. The authors used a mixed method. It included student surveys and pre-/post-study language competency assessments. Of course, the results demonstrated increased student motivation and participation. However, the study lacked longitudinal data. Therefore, it did not isolate the specific contribution of individual digital tools to language learning outcomes.

López Córdova (2024), using a case study design focused on language immersion in a digital environment, argues that natural language acquisition is facilitated by the constant exposure to English media and real-time communication applications. Although the article emphasizes strong student involvement and autonomy, it is limited by the small sample size. This reduces the generalizability of the results. Despite the sufficient evidence on the effectiveness of integrating multimedia in foreign language education, the results of these works remain inconsistent, such as studies that identify gamified platforms such as Duolingo, Kahoot and Quizlet. They are effective in increasing personalization and motivation (López Córdova, 2024). Although other authors warn against over-reliance on technology. Lee & Xiong (2022), point out the risks of distraction, cognitive overload and anxiety of students. The author emphasizes the importance of teacher mediation and pedagogical coherence when implementing digital tools. A particularly controversial topic is the use of artificial intelligence in learning. Huang et al. (2023) insist on its potential for hyper-personalization and adaptive learning pathways. While, Li (2019) writes about the reduction of opportunities for live interpersonal communication. The author argues that the use of artificial intelligence should be balanced with human interaction and teacher supervision.

Thus, such a diverse perspective highlights a critical gap in the existing literature. Although many studies focus on short-term benefits or isolated technologies, there is still a lack of holistic, comparative analysis

of multiple multimedia tools in real classroom settings. The proposed work aims to address this gap. The paper evaluates the effectiveness of a multimodal approach. Therefore, by comparing multiple digital platforms within a single pedagogical framework, it is possible to provide empirical evidence of the positive impact on student motivation and long-term language competence of combining traditional methods with adaptive multimedia tools.

Methodology

This study uses an experimental research method to examine aspects related to English language learning by integrating multimedia devices into modern teaching methods. Linguistic and pedagogical research methods were used to identify the most effective methodology for this experiment. This mixed methodology made it possible to use complementary research methods, which are shown in Table 1:

Table 1.
Research strategy

The research stage	Type of research	The aim of the study	Research tools	Participants of the study	Data analysis methods
1	Qualitative research	To understand the linguistic implications of multimedia For compiling and linking methods, pedagogical means of improving the level of motivation among students	Initial testing	5 English teachers from at least 10 years of experience	Comparative analysis of average scores
2	Quantitative research	To measure the effectiveness of multimedia programmes for level up motivation and haste	Surveys	120 participants (60 students per group) Control group: 60 participants. The experimental group: 60	Statistical analysis
3	Qualitative research	For a better understanding of multimedia applications students. To identify research gaps.	Observations.	Experimental group: 60 students Control group: 60 students	Content analysis

Source: authors' own development.

For this study, we relied on an experimental design. This allowed us to determine the impact of multimedia technologies on the quality of English language learning among the experimental group. This research type was chosen because it can establish cause-and-effect relationships between teaching methods and learning outcomes.

For the experiment, 120 participants were selected: two groups of students. The CG (60 students) studied English using the traditional methodology (lectures, self-study and standardised test tasks).

The EG (60 students) taught English using multimedia technologies (interactive platforms (Kahoot, Quizlet), video lessons, VR simulations and gamified tasks).

The experiment lasted 6 weeks.

The selected participants were divided into three levels of English: beginner, intermediate and advanced. The groups were formed randomly. This helped to avoid bias in the results.

The methods used to collect data included pre- and post-experiment testing, student questionnaires, and observation.

In the first stage, students took an English language test. Then, they were asked about their motivation, satisfaction with the learning process and level of engagement. Finally, the students' interaction with multimedia resources and engagement in learning were analysed.

The data were analysed using a comparative analysis of pre-and post-experiment scores for both groups, statistical analysis based on t-test and analysis of variance (ANOVA) to check the significance of changes, and content analysis of the survey. This allowed us to identify qualitative changes in students' motivation, satisfaction and engagement.

All the methods described above were used to determine the effectiveness of multimedia technologies in teaching English to students.

All instruments used in the study (English language tests, surveys and observation protocols) were peer-reviewed. The recommendations of the Common European Framework of Reference for Languages (CEFR) were followed. Regarding content validity, all language proficiency tests were adapted and validated by three experienced English teachers. Cronbach's alpha was used for the internal consistency of the motivation and engagement survey. The reliability score was 0.87. This indicates a high reliability of the results, which in turn were improved based on interrater agreement, with a Cohen's kappa of 0.82.

Group allocation was performed to control for researcher and teacher bias. Allocation was randomized. It was performed using a computer-generated randomization sequence. All teachers involved were not informed about the specific hypotheses of the study. Their interaction with students was monitored. This was to ensure consistency in the work carried out in different groups. The data was coded. To reduce subjective interpretation and to improve quality, the responses were anonymized.

Using thematic analysis, the content of the responses to the open-ended questionnaires was analyzed and observation notes were taken according to the six-phase model of Braun & Clark (2006). It included familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and compiling a report. This approach allowed us to identify key recurring patterns in the students' perception of multimedia use.

Reproducibility is presented in (English language proficiency test, full questionnaire on motivation and engagement, observation rubric used to assess engagement in classes and interaction with multimedia tools).

The proposed study is formally approved by the Institutional Review Board (IRB) of the affiliated university, and all participants provided informed consent for voluntary participation and the right to withdraw from participation at any stage. The work is completely confidential.

Results and Discussion

Modern methods of learning a foreign language (let us call them traditional since the theoretical model has been used for a long time without integrating the latest technologies) are based on authoritarian approaches. The teacher is the primary source of information and knowledge, while students passively absorb information. Therefore, we can immediately reject the grammar-translation, audiolinguistic, and direct teaching methods. These outdated methods no longer correlate with the needs of modern students. To confirm this opinion, we can highlight the shortcomings of traditional methods (Fig. 1):



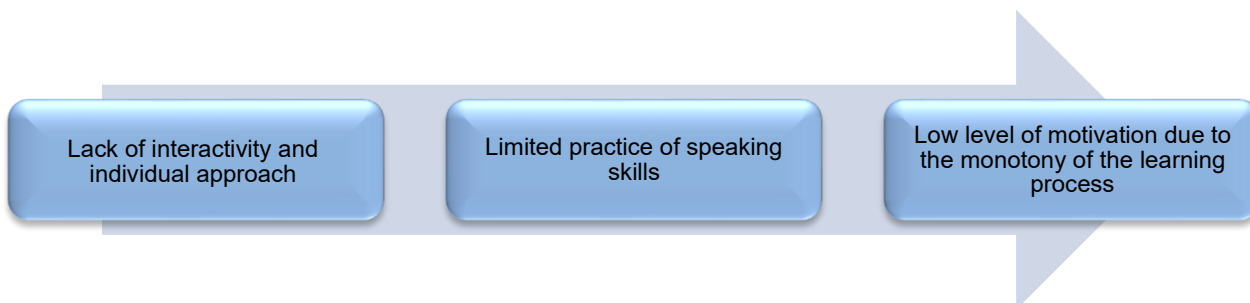


Figure 1. Problematic nature of sustainable approaches in the light of new technologies.

Source: authors' own development.

Accordingly, there is a need to find new approaches to engage students more actively in learning English. To increase students' engagement and motivation in learning English, we used multimedia technologies with a wide range of tools (Table 2):

Table 2.
Stages and types of multimedia technologies used

View	Opportunity
Interactive platforms - Duolingo, Quizlet, Kahoot	To enable self-study and repetition of the material
Video tutorials and learning videos - TED Talks, BBC Learning English	To develop listening and pronunciation skills
Virtual and augmented reality - headsets	To create immersion in the language environment, to promote better learning.
Mobile applications	For learning at any time, increasing the accessibility of the material.
Gamification	To use game mechanics to increase student motivation and engagement.

Source: Achkan, Vlasenko, Rovenska, Sitak & Chumak (2022)

Targeted multimedia technologies were supposed to improve the knowledge of the experimental group by enhancing interaction between students and teachers, promoting independence in learning, and providing a personalised approach to learning.

The study evaluated the effectiveness of multimedia technologies after the experimental study. CG studied using traditional methods, EG - using modern methods, using multimedia technologies for 3 months. The evaluation of effectiveness based on performance testing, questionnaires on the level of motivation and analysis of students' involvement in the learning process are presented below (Table 3):

Table 3.
Mean score of CG and EG before and after the test

Group	Grade point average (before)	Average score (after)	Improvement (%)
CG	62,4	68,1	9,1%
EG	61,8	75,3	21,8%

Source: Authors' own research.

Thus, the t-test shows an improvement in the experimental group. The improvement in learning outcomes is statistically significant ($p < 0.05$).

- The students in the experimental group showed significantly better results in listening (+20%) and speaking (+15%) tests.
- The level of motivation in the experimental group increased by 30% compared to the control group.

- Most students positively assessed the use of multimedia resources and noted that learning had become more interesting and understandable.

The next stage of the survey on student motivation showed the following results (Table 4):

Table 4.
Increased motivation according to the survey results

Indicator	CG%	EG%
High motivation	54,2%	78,5%
Recognised methods as effective	60,3%	85,6%
They found learning more interesting	52,1%	80,4%
We noticed better interaction	47,6%	82,9%

Source: Authors' own research.

According to the content analysis of students' open-ended responses, multimedia technologies contribute to better learning and increase motivation to learn English. In the third stage of the experiment, the teachers provided information about their observations of the learning process. According to the analysis of students' interaction with multimedia technologies, EG participants actively interacted with the material and used independent information search more often. The attention and concentration of the EG participants were higher than those of the CG.

Accordingly, the overall improvement in results is shown in (Fig. 2):

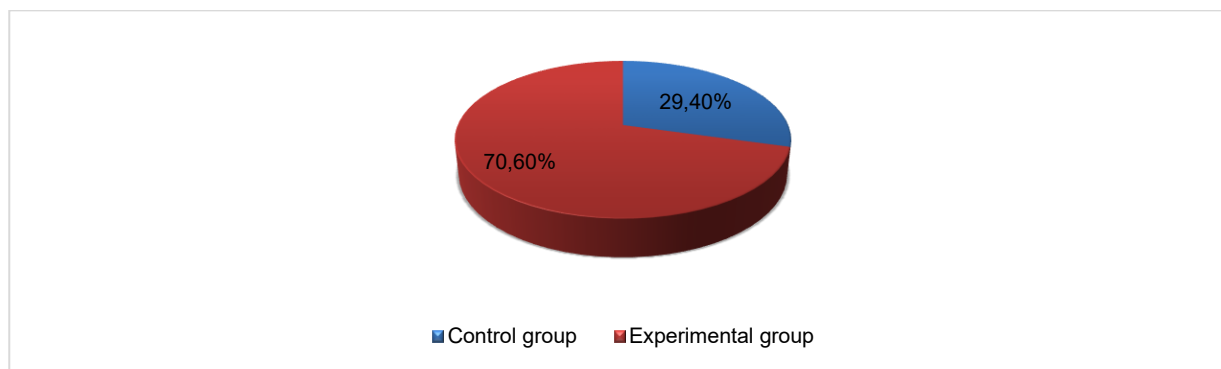


Figure 2. Level of knowledge after the experiment.

Source: Authors' own research.

Accordingly, in the CG, there is an increase (+9.1%), in the EG - (+21.8%)

The results demonstrate that multimedia technologies are practical tools for teaching English, improving students' performance, increasing motivation and creating an interactive learning environment. Multimedia adapts learning to the needs of modern students. Integrating multimedia technologies into English language teaching methods makes learning more effective and engaging.

The use of multimedia technologies remains very diverse, as the new technologies themselves represent a multiplicity of different tools and means. Yemelyanova et al. (2022) speak of multimedia as an extremely heterogeneous construct that can cover the aspect of images, databases, encyclopedias, learning environments, and which can be related to such different fields as psychology, education, pedagogy. Thus, it can be argued that multimedia technologies have a complex and diverse impact on all areas.

The first working question focused on the relationship and impact of multimedia technologies on education, especially in English language learning. In this context, Yuhan et al. (2024) emphasise that in order to

understand the effectiveness of multimedia, it is first necessary to determine how multimedia technologies can be used in relation to foreign language learning and teaching.

Afrilyasanti et al. (2022) describe the historical relationship between language and computer science. The authors note that the first works that put computer languages at the service of computer science languages coincide with the emergence of computer science itself. Subsequently, from the seventies to the present day, there has been a constant interaction between new technologies and education (Alenezi, 2023).

Thus, the results of the proposed study revealed a statistically significant improvement in language acquisition and motivation of students in the experimental group that used multimedia technologies. Such data are consistent with the results of Yuhan et al. (2024). The authors emphasize the increase in student engagement due to interactive video content. However, their study focused mainly on vocabulary memorization. While in the proposed study, significant improvements were observed in all four language skills (speaking, listening, reading, writing). This indicates the advantages of a multimodal approach.

Orsoni (2024) nevertheless expresses concern about the use of multimedia. The author insists on the reduction of critical thinking due to the excessive use of gamification. Of course, our results showed an increase in motivation during gamified classes. However, it also turned out that students in the experimental group demonstrated stronger independent task completion by the fifth week of the program. This could be due to the structured integration of reflective components (written summaries after completing the task). Thus, there is evidence that the design and context of multimedia integration are key to the effectiveness of language learning.

Nicolaou et al. (2019) talk about the importance of adaptive learning platforms. They are indispensable for adapting content to individual needs. The authors emphasize the variability of effectiveness depending on the initial level of language proficiency of students. The proposed work included participants at beginner, intermediate and advanced levels. However, no statistically significant differences in improving performance between levels in the work were found. Therefore, it can be argued that although adaptive platforms can improve personalization, there are other factors for improvement. Particularly important are teacher support and content quality. They are the ones that mitigate their overall impact.

Although the findings of the relevant works confirm previous studies, our work offers new depths. The results show the effective impact of multimedia tools on motivation and performance. Learner autonomy and sustained engagement over time are also at stake. The results of the proposed work highlight a gap in previous research. They tend to focus on short-term effects, while omitting long-term integration into pedagogical practice.

This interaction eventually moved logically into the field of foreign language learning. Khue Dinh (2025) explains this strong connection from two perspectives - sociological and didactic. In this context, Devadze & Gechbaia (2024) say that modern language learning is one of the areas where technological tools are used the most and the earliest. Alrikabi et al. (2022) explain this by both the exponential growth of social demand for language learning and a certain tradition of self-education in this area. Today, behaviourist methods, which some scholars have interpreted as outdated have adapted well to language applications (Belda-Medina & Calvo-Ferrer, 2022).

The position of some scholars on the use of multimedia technologies for learning foreign languages is interesting. In his classification, Orsoni (2024) identifies three ways of using them: free use of technology, without being a carrier of any didactics, the user must program his or her learning (for example, working in Microsoft Office), the use of less specific software that performs a specific didactic and pedagogical role (for example, gamification), and the use of artificial intelligence products. These uses demonstrate how the relationship between technology and language learning in general can be productive. If we transfer the general practices to the specific area of English language learning, it would be wise to approach the issue in light of pedagogical trends that encourage or discourage the use of multimedia to varying degrees.



In the context of the second working question on motivation, it should be noted that motivation plays a key role in foreign language learning.

Modern language learning methods, such as the audio-oral method, are fully adapted to the use of multimedia. Nicolaou et al. (2019) write that language is conceived as a network of syntactic structures that need to be learnt in the form of automatisms. In this sense, multimedia technologies have an identical principle. Their use can only bring positive benefits, as it is the par excellence tool for introducing language automatisms (Sherman et al. 2022; Saienko, 2023). The same can be said about the structural-global method for learning foreign languages. Its conception of language as a global and structured form that has to be learned in its entirety without fragmentation can also be effectively combined with multimedia tools (Puebla et al., 2022). Through audiovisualisation and subtitling, Multimedia may well present the language as an organised whole (Mkrtychian et al., 2019).

Thus, traditional methods of foreign language learning are readily aligned with the use of new technologies (Jie & Sunze, 2023). Paradoxically, the most outdated teaching methods, which are less likely to use new technologies as direct teaching tools, can be combined with multimedia devices (Ikwuka et al., 2024). The communicative approach and activity-based approach, for example, make multimedia an ideal tool for traditional learning (Kharroubi & ElMediouni, 2024). Legemaate et al. (2022) argue that language is primarily a communicative skill and relegates purely linguistic and syntactic competence to the background. Thus, it is up to the teacher to assess the need to use multimedia in a given situation. Martín-Sómer et al. (2024) write that the use of multimedia has already become a teaching tool, and it is by far the most common use in the field of foreign language learning to increase student motivation and engagement.

New technologies have developed so rapidly that it is the way of understanding these technologies that are poised to democratise new education (Iyamuremye et al., 2022). Any person today can work with technology with more or less initiation thanks to pre-programmed software, unlike older programs that require knowledge of a specific computer language. Nevertheless, technical training of teachers is important for language learning and didactics, as it covers deeper processes of methodology and technology (Damayanto et al., 2022).

It is up to the teacher to choose the methodology and implement multimedia technologies to support it. These tools offer the teacher tools designed for teaching and, in particular, for in-depth analysis of student performance, motivation and engagement (Garvasiuk & Namestiuik, 2022; Kokkonen et al., 2022).

In the context of technological advances in foreign language teaching and learning, there is a tendency towards the radical trivialisation of the Internet, which ultimately leads to a variety of technological applications for teaching and learning foreign languages. Both teachers and students are faced with constant change and a multiplicity of new technologies (Griffin et al., 2024). The variety of ways in which new technologies are used eludes analysis of their effectiveness. Faced with this wave of technology in the field of foreign language learning, we should not forget that learning a foreign language solely through multimedia in isolation from a specific methodology is unthinkable.

Therefore, the results of the study indicate the effectiveness of multimedia technologies in increasing students' motivation and success in learning English. These results are consistent with many studies. However, there are still cases of overload among elementary students. These cases partially confirm the warnings of Han & Yin (2023) regarding the excessive cognitive complexity of VR environments. For the successful integration of multimedia, the qualifications of teachers and the adaptation of content to the level of students turned out to be an important factor. Although the topic is fully disclosed, this study has limitations. First of all, it is about the limited sample and the short duration of the experiment. The results of the proposed work emphasized the feasibility and effectiveness of using multimedia tools within the framework of blended learning. Therefore, further research is needed to assess their long-term effect.

Conclusions

The results of the study prove that the integration of multimedia tools has a significant impact on increasing students' motivation. The tools improve the development of foreign language competence, thus improving the quality and content of education.

The data obtained after the experiment showed that students who studied using multimedia technologies showed higher test scores. In addition, they were more engaged in the learning process than the control group. Therefore, integrating multimedia such as interactive platforms, video tutorials, mobile applications and virtual reality can contribute to deeper learning. The development of language skills, including listening, reading, writing and speaking, has improved significantly.

The study emphasises the need for an effective combination of traditional and multimedia methods of teaching English. This combination creates an adaptive learning environment. Classical pedagogical strategies and the integration of multimedia technologies motivate and engage students in learning English. Despite the new opportunities for improving the quality of English language teaching, the use of multimedia interactive technologies requires the improvement of educational programmes. This will be an important step in modernising the foreign language teaching system.

Thus, the study's results demonstrate the effectiveness of using multimedia technologies in teaching English. Students' performance improved significantly, and the experimental group members became more motivated and spoke about the comfortable educational environment. However, we should not forget the need to train teachers to achieve maximum implementation of multimedia in the learning process.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.6>

Cómo citar:

Kolechynitseva, T., Boitsun, I., Dronov, N., Yordan, H., & Tytar, O. (2025). Education 4.0: Development of the ukrainian educational system in the context of artificial intelligence. *Revista Eduweb*, 19(2), 82-94. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.6>

Education 4.0: Development of the ukrainian educational system in the context of artificial intelligence

Educación 4.0: Desarrollo del sistema educativo ucraniano en el contexto de la inteligencia artificial

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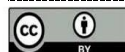
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Recibido: 16/03/25

Aceptado: 19/05/25

Abstract

This article aims to analyse the concept of Education 4.0 and its key achievements, challenges, and prospects in the context of artificial intelligence development in the Ukrainian educational system. The study explores the transformation and digitalisation of Ukrainian education, including the impact of artificial intelligence on pedagogical methods, the training of qualified professionals, the development of innovative curricula, and ensuring free and continuous access to high-quality education. The research methodology is based on an in-depth analysis of modern literature, examining successful cases of artificial intelligence



integration into Ukrainian education. Particular attention is paid to the modernisation of education through AI-driven solutions, the opportunities and challenges of Education 4.0, and the AI systems that actively support contemporary learning. The findings highlight the potential of Education 4.0 in fostering personalised learning, enhancing the competitiveness of Ukrainian education, and aligning it with European standards. However, multiple challenges hinder its effective implementation, including the Russian invasion, technological disparities across regions, a shortage of retrained specialists, and risks associated with excessive automation, which may diminish the human element in education. This study contributes to the ongoing discussion on adapting Ukraine's education system to the demands of digital transformation.

Keywords: digital competencies, digital pedagogy, interactive learning, learning platforms, personalised learning.

Resumen

Este artículo tiene como objetivo analizar el concepto de Educación 4.0 y sus principales logros, desafíos y perspectivas en el contexto del desarrollo de la inteligencia artificial en el sistema educativo de Ucrania. El estudio examina la transformación y digitalización de la educación ucraniana, incluyendo el impacto de la inteligencia artificial en los métodos pedagógicos, la formación de profesionales cualificados, el desarrollo de planes de estudio innovadores y la garantía de acceso libre y continuo a una educación de alta calidad. La metodología de investigación se basa en un análisis exhaustivo de la literatura moderna, destacando casos exitosos de integración de la inteligencia artificial en la educación ucraniana. Se presta especial atención a la modernización educativa mediante soluciones impulsadas por inteligencia artificial, las oportunidades y desafíos de la Educación 4.0 y los sistemas de inteligencia artificial que apoyan activamente el aprendizaje contemporáneo. Los hallazgos resaltan el potencial de la Educación 4.0 para fomentar el aprendizaje personalizado, mejorar la competitividad de la educación ucraniana y alinearla con los estándares europeos. Sin embargo, múltiples desafíos dificultan su implementación efectiva, incluyendo la invasión rusa, las disparidades tecnológicas entre regiones, la escasez de especialistas capacitados y los riesgos asociados con una automatización excesiva que puede reducir la interacción humana en la educación. Este estudio contribuye al debate sobre la adaptación del sistema educativo de Ucrania a los desafíos de la transformación digital.

Palabras clave: competencias digitales, pedagogía digital, aprendizaje interactivo, plataformas de aprendizaje, aprendizaje personalizado.

Introduction

Ukrainian education is currently undergoing profound transformation processes, both internal and external. First, it is a change in approaches to the learning process aimed at applying the latest technologies while maintaining personalised learning. Secondly, Ukrainian education is heavily affected by the pandemic, the Russian-Ukrainian war, and economic and demographic difficulties. In the face of such influences, it is necessary to find the driving factors that will ensure that education remains effective and ensures its development even in extremely difficult times. In the past, these factors depended on human potential: the qualifications of teachers and the motivation of students. However, the current situation in Ukraine is characterised by the migration of a large number of young people abroad and the loss of skilled workers in the war zone. At the same time, against the backdrop of the rapid development of digital technologies, issues of ethics and pedagogy in the educational process are becoming increasingly relevant. In particular, the use of technologies, including artificial intelligence, causes not only excitement due to new opportunities, but also concern due to potential risks. In particular, in the scientific space, various risks are highlighted, ranging from the loss of authenticity of learning to the reduction of the role of the teacher as a mentor. Therefore, there is a need to carefully consider how AI can harmoniously integrate into the education system without violating its humanistic principles.

Therefore, there is an increasing need to use advanced information and communication technologies that can provide organisational, pedagogical, educational, methodological and cognitive processes



(Boiko et al., 2024). Based on the challenges faced by Ukraine, its experience in implementing rapid change is unique and allows us to analyse the impact of integrating innovative technologies in an unstable economy and civilian security environment. Education in Ukraine is developing quite dynamically: the impact of the COVID-19 pandemic and the full-scale war have led to a shift in education from traditional methods to online learning. Under these conditions, the transition to information and communication technologies and their deeper study has become relevant. At the same time, artificial intelligence technologies are beginning to shape a new era of education (Vasylyuk-Zaitseva et al., 2023). However, even though artificial intelligence is a concern for many researchers, its application in the Ukrainian education system can be a salvation. The use of artificial intelligence in Ukraine has not yet become widespread, but it has already had positive results. Education in Ukraine needs to change dramatically, so it remains important to introduce innovative pedagogy and move to 4.0 programmes that meet the modern challenges of the fourth industrial revolution (Malynovska & Smyrnova, 2023). It will have a powerful impact on the transformation of all humanity, as it involves a symbiosis between humans, machines and artificial intelligence. And education is becoming a key area of transformation. The modernised approach to education influenced by the 4th Industrial Revolution provides a modern understanding of changes in learning modes (Sharma, 2019). Researchers believe that these changes have a global impact, and Ukraine is no exception (Shlenova et al., 2024). For Ukraine, this transition is critically important. The introduction of artificial intelligence can improve the quality of education by personalising learning, automating monotonous work, and developing digital skills. The 4.0 programmes in Ukraine aim to develop key skills of a future specialist: critical thinking, creativity, teamwork, digital literacy, and motivation for continuous development (Honcharuk et al., 2024). This system must adapt to the current difficult realities of war, insufficient financial support from the state, insufficient software, uneven access to modern technologies, and low digital competence of students and teachers. Despite the barriers, the transformation of education in line with the 4.0 concept is a key prerequisite for ensuring the quality of society's development and Ukraine's integration into the global digital space. The purpose of the study is to analyse the impact of artificial intelligence on the Ukrainian educational system in the concept of Education 4.0, to identify opportunities and challenges for the introduction of interactive technologies, and to develop and implement the latest technologies to ensure quality education. The objectives of the article are to analyse the main concepts of Ukrainian Education 4.0, to explore the potential of using artificial intelligence technologies in education and to discuss the main challenges to the implementation of this concept.

The article consists of several sections. The first section - a review of the literature presents the theoretical framework of the study and a critical analysis of recent research. The second section - results and discussion describes the impact of modern technologies on the development of education in Ukraine and identifies the role of AI in the development of education in Ukraine. Also in this part, the obtained data are discussed and compared with other scientists. The third part - a generalization and summary of the obtained results are made and promising directions for the development of Education 4.0 are described.

Theoretical Framework or Literature Review

The transition of Ukrainian Education 4.0 as an important stage in the formation of competitive specialists is determined by the introduction of the technologies of the Fourth Industrial Revolution. The integration of artificial intelligence aims to turn education into a personalised, adaptive and accessible experience for everyone. In recent years, artificial intelligence has increasingly attracted the attention of scientists around the world, as this field is still not sufficiently studied. Yesilevskyi & Kyt (2024) study the development of computer technologies under the influence of artificial intelligence. The authors focus on the rapid transition from traditional teaching methods to the integration of the latest technologies due to COVID-19 and the introduction of martial law in Ukraine, as there is an urgent need for distance education (Tsekhmister et al., 2021). Nowadays, innovative tools are most often used: mobile applications, platforms, and cloud services, which provide continuous access to information (Kuzmenko et al., 2023). AI technologies such as machine learning, intelligent tutoring systems, and automated tools enhance personalized education, streamline data analysis, and improve educational processes (Synorub & Yordan, 2024). Researchers have studied the European experience of introducing innovative technologies. They found that most teachers have a

sufficient level of digital competence, so the European experience is based on the ability to withstand challenges. However, these challenges cannot be identified with those in Ukraine. However, using the example of Ukraine (Bader et al., 2022), the authors demonstrate the positive experience of teachers' information competence and emphasise the importance of supporting the motivational component to overcome obstacles related to the fear of using the latest technologies due to their ignorance. Digital competencies influence curricula, teacher competence, and resources for students (Bobrytska et al., 2024).

The authors emphasise the growing recognition of artificial intelligence technologies. However, in order to ensure its successful integration, it is necessary to address crucial issues related to the quality of content, ethical implications, and the need for comprehensive development. We must approach artificial intelligence holistically. To understand its implementation, it is necessary to analyse the relationship between artificial intelligence tools and the human mind. This answer will provide the necessary information on how artificial intelligence can complement human creativity and help in the educational process. However, researchers call for a balanced use of artificial intelligence, as it should not replace humans but help and complement them. Modern professions are beginning to undergo changes, where a specialist must have knowledge of the latest technologies (Kornytska et al., 2023). Special emphasis is placed on the development of soft skills as a requirement for future employees. In order not to be left on the sidelines of globalisation, Ukrainian education must also be ready for change. This aims to modernise the educational system, which will focus on the development of critical thinking, skills in using the latest technologies and practical competencies of students. The main areas are the introduction of programming, robotics and engineering. However, there are many challenges to its implementation. Introducing artificial intelligence into the Ukrainian education system is still needed to create favourable conditions for inclusive learning (Hudym et al., 2024). This will create the preconditions for meeting the needs of children with special needs. Artificial intelligence can address the need for personalised learning, creating a comfortable learning environment and automatically monitoring students' results. Inclusive education combined with artificial intelligence can reduce stigma, increase the development of social skills, and significantly empower people with special needs while facilitating continuous access to quality education. Interactive whiteboards based on artificial intelligence have contributed to better learning and personalisation of the process for students with different needs. For teachers, this method allows them to expand inclusive methods. The introduction of artificial intelligence facilitates routine work, provides psychological support to participants in the educational process, creates high-quality educational materials, and improves the curriculum (Ivanashko et al., 2024).

Artificial intelligence tools can prepare students for future professional activities and develop important competencies. Studies show that AI tools are already being actively used in training specialists in the sciences and humanities, as well as interdisciplinary specialties such as sociology. Artificial intelligence has unlimited potential for use. These tools help to analyse, interpret and manage large amounts of data, create predictive models in experimental research, solve laboratory problems, and create a safe environment for dangerous experiments. For humanities students, AI can help analyse text, write annotations and conclusions, and compare what they have written with other studies. Researchers are discovering even more possibilities of artificial intelligence (Ahmad et al., 2022). The role of artificial intelligence is important not only for academic applications but also for administrative activities. Such applications help teachers give grades, manage attendance, and determine the level of intelligence. Teachers can easily prepare for classes and, with the help of virtual reality technologies, help students master complex but interesting topics. AI also helps with administrative issues, such as budgeting, resource management, exams, and important documentation. However, some authors believe that using artificial intelligence in education has no connection with education (Chiu et al., 2023). The authors argue that teachers do not understand technology enough to be able to apply it in the classroom. Teachers are often unaware of the capabilities of the latest technologies, so there is uncertainty about the implications of the pedagogical use of innovative technologies. Artificial intelligence often lacks an interdisciplinary approach (Bates et al., 2020).

Thus, technologies developed for a particular discipline may be ineffective for teaching all students. Artificial intelligence technologies are lagging in education. Teachers continue to use traditional methods in the classroom, avoiding integrating anything new. AI technologies can motivate students to learn, but only the



most competent ones get the most out of these technologies. AI can change industries, but not all of them. The main limitation is that data-based learning is only possible (Yuskovych-Zhukovska et al., 2022). This means that any error will be reflected in the learning outcomes. The study of teachers' competence in using artificial intelligence technologies proves the need to improve their qualifications and skills in using the latest technologies (Kyrpa et al., 2024).

The potential of artificial intelligence has been identified as having the ability to revolutionise education by providing personalised learning and instant feedback (Drach et al., 2023). There are many artificial intelligence tools, and the authors believe it is up to the teacher to choose the most convenient ones. At the same time, it is important to understand and adapt artificial intelligence, as it may have a false generation of answers and results. The study's authors value the human mind as unique and creative (Yara et al., 2021). Bashkirova et al. (2024) also addressed similar issues, which allowed them to were able to trace the importance of involving artificial intelligence systems in modern education. Some caveats that these researchers were able to categorize are important, since the use of new platforms also involves certain risks. Babych et al. (2022) analyzed, for example, the importance of medical indicators, for example. The thorough methodology of their study is a relevant addition, as it can complement the study, which can add to the understanding of the possibilities for further improvement of education. Similarly, Polyezhayev et al. (2024) noted the usefulness of digitalization in the field of learning foreign languages and acquiring relevant linguistic skills. In particular scientists noted the possibility of facilitating the creative process of acquiring education, without immersion in formal tasks. And artificial intelligence is just a tool that can facilitate routine work and save invaluable time. When using artificial intelligence technologies in education, it is important to follow the rules of ethics and confidentiality of information. The analyzed works belong to various methodological types. Some studies have thorough empirical data, however, in most of them the sample is not large, which in general complicates the process for analysis. In addition, many studies are more of a review. Accordingly, the scientific space lacks studies that would systematize existing research and describe the role of AI in the Ukrainian Education 4.0 system.

An important drawback of the available publications is their local nature. In addition, many articles do not provide specific data from Ukrainian educational institutions on the practical implementation of technologies and their effectiveness. The analyzed works also do not clearly state what impact AI has on the academic achievements of students with different levels of training. Another notable aspect is the lack of attention to the level of pedagogical training of teachers. However, a particularly important drawback is the lack of coverage of the challenges of using AI in the Ukrainian education system. This study will fill these gaps and describe the main characteristics of the Ukrainian Education 4.0 system and the challenges of implementing AI in current education.

Methodology

The study of the impact of artificial intelligence within the Ukrainian Education 4.0 system concept involves using different approaches. This study focused on using general scientific, pedagogical and synergistic methods. The main focus was on analysing the innovative elements that shape the modern education system under the influence of the challenges that Ukraine is facing. The study offers a detailed review of the literature on the introduction of artificial intelligence in the education of Ukrainian schools and higher education institutions. Scopus, Web of Science, PubMed, Google Scholar, and local sources were used to search for scientific literature. The keywords used in the selection of scientific sources were education 4.0, artificial intelligence, AI, schools, universities, AI technologies, adaptive learning, smart education, education reforms, teacher training, student outcomes, education digitalisation, opportunities, challenges, higher education, machine learning, AI tools.

In more developed countries, the introduction of artificial intelligence has been active in recent years, while in Ukraine, this process is only in the development stage. Therefore, the analysis of scientific literature sources is based on studies of recent years, when there is only a description of the introduction of this system in education, but its consequences have not yet been substantiated, or they exist, but there are



very few studies. The sources of literature were selected according to the following criteria:

1. Research related to AI in education.
2. Overview of Education 4.0 with a focus on personalisation and technology.
3. Articles published since 2015 (when the topic of AI in education began to develop actively).
4. Publications related to the Ukrainian educational system.
5. The language of writing is Ukrainian and English.

The exclusion criteria were:

1. Studies that do not cover the educational context (e.g., general AI technologies).
2. Publications are available only in abstract form.
3. Works that do not correspond to the linguistic or regional context (unrelated to Ukraine).
4. Works written in other languages (except English and Ukrainian)

Using these criteria, 45 scientific literature items were selected, which are dedicated to modern technologies and the use of AI in the Ukrainian Education 4.0 system. The duration of the analysis is from December 2024 to February 2025.

After the initial selection, the sources were analyzed and grouped into thematic categories: (1) implementation of AI in the educational process, (2) inclusion, (3) pedagogical challenges, (4) ethical aspects, (5) administrative use of AI. This made it possible to identify the main trends and contradictions in the scientific discourse. In addition, pedagogical methods such as pedagogical observation and generalisation were used to assess the effectiveness of artificial intelligence. The synergistic approach was based on studying the interaction between the educational system and artificial intelligence technologies. Comparative analysis was used to analyse the differences between the Ukrainian and international experiences of integrating artificial intelligence into education. The application of artificial intelligence technologies and analysis of the experience of its integration into Ukrainian educational institutions allows us to determine the prospects for developing Education 4.0 as the future education.

To ensure the reliability of the results, elements of triangulation were used: comparison of data from different sources, analysis of the views of different authors, and comparison of the international and national context. Some of the sources were previously evaluated by experts (peer review), which reduces the risk of bias. Potential cognitive biases were also considered through a systematic and critical approach to text analysis.

Results and Discussion

The main purpose of this study is to investigate the impact of the fourth industrial revolution on Ukrainian education with a focus on the use of artificial intelligence. In Ukraine, few researchers describe this topic because the latest technologies have not appeared so long ago, and their integration takes a lot of time. In addition, the number of studies on the impact of artificial intelligence is quite small. And not much time has passed since its integration to talk about its impact on Ukrainian society. We are taking small steps to overcome the barriers from education 3.0 to education in more developed countries. For example, the fourth industrial revolution in Germany was first called Industry 4.0. For the first time, the country approved two state programmes focused on developing technology and the Internet (Lokshyna et al., 2021). A key element of Industry 4.0 is global digitalisation, creating "digital twins", cyber-physical systems, merging the real and virtual worlds, augmented reality technologies, and artificial intelligence. These programmes are active in the United States, the United Kingdom, Belgium, France, and Japan. Australia uses the Industry 4.0 programme to conduct research projects and commercialise new developments. In Germany, a similar programme is working to develop research activities in the industrial sector. Japan is implementing the Society 5.0 concept, which is a direct continuation of the Industry 4.0 programme, adding a socio-cultural component to it, i.e. solving society's problems through cyberspace (Kuchai et al., 2017). Ukraine only aims to achieve such goals shortly (Yershov, 2019).



The Fourth Industrial Revolution is a step towards expanding knowledge, where the boundaries between the physical, digital and biological fields are blurred, as Schwab (2016) notes. The revolution is changing life, work and relationships thanks to digitalisation processes. As these processes are happening quite quickly, people need to be able to adapt in time. It is expected that in the future, such technologies will be integrated into one system. They can communicate with each other in real-time, self-adjust and learn new behaviours. This can reduce the number of errors and adapt to users' needs. Cloud technologies, big data processing, biotechnology, 3D-printed medicine, and cryptocurrencies have been the first steps in the world of the new industrial revolution. However, despite economic development, society faces the problems of unemployment, social inequality, climate change, and pandemics (Williams et al., 2023). The gap between rich and poor is widening; millions cannot find work, and wages in some countries continue to decline. Therefore, it is illogical and wrong to continue on this path. The impact of the Fourth Industrial Revolution on higher education means the emergence of a new format of educational institutions that provide new approaches to the learning process. These institutions will be transformed into those that will become independent of state funding and increasingly contribute to developing a competitive society (Miranda et al., 2021).

Education 4.0 in Ukraine is the education of a knowledgeable society that provides training, retraining and advanced training. The purpose of Education 4.0 in Ukraine is to ensure the comprehensive development of students by their needs and the needs of socio-economic systems, to integrate the Ukrainian education system into the European and global educational space, and to increase the competitiveness and development of educational institutions.

Education is one of the key factors in the formation of a coherent society. Ukraine is undergoing significant socio-economic changes and is reforming its education system by introducing modern technologies into the learning process. For Ukraine, Education 4.0 is an urgent need to create an advanced education system that will meet all the challenges of the Fourth Industrial Revolution. To this end, on 10 December 2022, a programme for a major transformation of Ukraine's education - Education 4.0: Ukrainian Dawn - was presented. It is based on rethinking education and ensuring the transition from standardised teaching methods to personalised learning, from a system where learning and skills are improved throughout life. The main principle of Education 4.0 is to invest in one's future and to adopt a human-centred approach that meets the core competencies of modern education (Table 1).

Table 1.
Core competencies of Education 4.0

Competences	Description	Example
Digital literacy	Ability to use digital technologies for learning and content creation.	Work with e-learning platforms, programming, digital resource management.
Critical thinking	Analysis and evaluation of information, search for solutions.	Ability to distinguish facts and analyse sources of information.
Creativity	Ability to create innovative ideas and solve problems out of the box.	Generating new approaches to learning.
Communication	Effective interaction in various formats, including digital environments.	Virtual presentations, collaboration through online tools.
Information literacy	Ability to find, analyse and use information.	Search for relevant information through scientific databases.
Emotional intelligence	Understanding and managing own emotions, effective interaction with people.	Conflict resolution, creating a positive learning environment.
Interdisciplinarity	Integration of knowledge from various fields.	Combining STEM education with humanities, project activities.
Flexibility and adaptability	Ability to adapt to change and learn new things quickly.	Mastering new technologies and adapting to changes.

Source: Authors' own research

Traditional Ukrainian education has begun to give way to the latest teaching methods that can consider an individualised approach to each student. For Ukraine, Education 4.0 is a salvation and a response to the challenges of globalisation and digitalisation. This concept modernises how material is transmitted and presented and puts the individual's needs and capabilities at the centre of the learning process. Many authors emphasise that the successful implementation of this project requires government support, which concerns not only the financial component but also the creation of a regulatory framework (Malieiev et al., 2024). In addition, international cooperation with other countries is important for expanding and gaining new experiences.

Thanks to artificial intelligence technologies, personalised learning is now possible. Barvinok & Pudlô (2023) believe that during the Russian-Ukrainian war, the key is to introduce distance or blended learning, as many students cannot study full-time.

The latest technologies make it possible to create such an individual educational trajectory, considering the learner's strengths, interests and the pace of information assimilation. At the same time, a number of serious challenges stand in the way of future education (Skoromnyi et al., 2021). First of all, these are the limitations between the regions of Ukraine. The study by Karpenko et al. (2020) shows that access to the Internet and high-quality and modern equipment is limited in rural areas. Such regions will already be somewhat behind more developed ones, as the conditions created are unequal for teachers and students, creating social and digital inequality at this level. However, the researchers propose solutions to these problems through investments in digital development, the creation of digital literacy programmes, and support for entrepreneurship in technology. Another problem is teachers' insufficient training in using artificial intelligence technologies (Chernenko, 2021).

Education 4.0 requires teachers to be able to work with interactive whiteboards and use data to assess students' progress. This requires retraining of teachers, courses and webinars. It may be especially difficult for older teachers who rarely use the latest technologies due to their lack of knowledge (Dovgyi et al., 2020). Researchers believe that when creating new technologies, such people's needs are often not considered (Chu et al., 2022). In Ukraine, Koka (2023) concludes that separate support should be organised for senior teachers in the form of seminars, webinars and trainings, which are the administrations of educational institutions are already implementing.

A separate issue remains state funding for the modernisation of education, the purchase of equipment and the development of modern platforms.

Education 4.0 is a challenge and an important step towards modernising the modern education system. This implementation requires the efforts of all participants in transforming education (Table 2).

Table 2.

Key aspects of education transformation in Ukraine in accordance with the Education 4.0 concept

Category	Description	The role of artificial intelligence
Digital platforms	Use of online tools for organising the educational process and distance learning.	Analysis of applicant data, personalisation, and automatic progress monitoring.
Interactive tools	Use of interactive whiteboards, simulators and VR/AR.	Content generation, simulation of learning situations and gamification.
Inclusion in education	Integration of children with special educational needs into the educational process.	Creating individualised curricula, adapting materials and improving the accessibility of educational resources.
A personalised approach	Focusing on the individual characteristics of applicants and their strengths.	Analysis of test results, identification of strengths and weaknesses, recommendations for correcting the learning process.
Development of critical thinking	Developing skills in analysis, argumentation and decision-making.	Modelling situations to develop critical thinking, analysing data and predicting decision outcomes.

Source: Authors' own research.

Today, artificial intelligence is beginning to play a central role in the transformation of Ukrainian education. This allows not only the transformation of the educational process but also the creation of preconditions for the development of creativity, critical thinking, and individualised learning. One of the main advantages of artificial intelligence is task automation when systems make it easier for teachers to analyse students' performance. According to Liubarska (2024), such systems allow teachers to save time on preparation, focusing on the creative and imaginative part of the work. However, Kyrychenko (2020) describes the loss of "human" imagination and creativity, which can easily be replaced by artificial intelligence. At the same time, this will reduce critical thinking and social interaction, and there is a risk of losing cultural identity in the context of globalisation (Wojciech et al., 2021).

Nevertheless, thanks to artificial intelligence, education is becoming more and more accessible to everyone anytime, anywhere, without restrictions.

In the European Union, artificial intelligence is actively used to personalise the learning process. The UK has long been using personalized technologies based on the needs of students. Artificial intelligence analyses their behaviour and mental abilities and generates appropriate tasks (Zhang et al., 2021; Krap et al., 2024). Digital teaching assistants are being actively introduced to provide recommendations and improvements to the curriculum. This allows teachers to correct the programme in time. In Germany, virtual student assistants are used to support the learning process. Such assistants can help answer questions, plan the day, organise studying, and even conduct study sessions.

Ukraine, on the other hand, can only adopt the experience of European countries for the time being. It is only on the verge of transforming the educational process. Nevertheless, there are many initiatives that demonstrate good prospects for this area. For example, artificial intelligence-based platforms are now being actively used in schools and secondary and higher education institutions. The All-Ukrainian Online School, created by the Ministry of Education and Science of Ukraine, has already become an important addition to the development of distance learning. This platform uses artificial intelligence to automate processes, create learning materials and curricula, and analyze student performance. It can offer assignments in various disciplines and quick feedback. At the same time, studies describing cases in specialized inclusive institutions indicate that after the implementation of interactive whiteboards with AI elements, the engagement of students with special needs improved by 35% (Bobro, 2024; Bobrytska et al., 2024). In addition, the study by Vasylyuk-Zaitseva et al. (2023) using indicators such as RRMF (Relative Ranking Mean Factor) and RRP (Relative Ranking Priority) indicates that in the process of modernization of the Ukrainian education industry, artificial intelligence technologies selected from the general rating: -EdTech: 0.0476 (RRMF); 0.083 (RRP) indicates that digital tools and resources are available for effective learning, which stimulates changes in forms of learning; -Virtual and augmented reality (VR/AR): 0.0595 (RRMF); 0.059 (RRP). This technology creates an immersive learning environment that allows students to engage and immerse themselves in real-world scenarios.

The Smart Education platform provides access to interactive lessons that adapt to users' knowledge. The platform's artificial intelligence analyses students' achievements, identifies their strengths and weaknesses, and offers the necessary materials for revision. The Prometheus and EdEra platforms are very popular among Ukrainian teachers. These elements are very useful when searching for materials and lectures in various disciplines. They also offer many webinars and trainings, which are always relevant for teacher training. E-journal platforms allow you to monitor students' progress and attendance. AI tutors and chatbots, such as ChatGPT, have only recently started working in Ukraine but have already become one of the most popular applications (Fiialka et al., 2023). International platforms such as Coursera, Duolingo, and Udemy are also in high demand. Mobile applications, especially, are very convenient to use.

Ukraine has the potential to become a country with a European level of education. Potential areas for the development of artificial intelligence include the creation of a single national adaptive platform, the development of analytics tools, and support for STEM education. The national platform could provide personalised learning to the needs of everyone and create an educational space that would be common to

all educational institutions. The development of analytical tools through the analysis of large amounts of data will allow us to monitor student performance, make predictions and new teaching approaches, and free teachers from routine work. Supporting STEM education in Ukraine plays a key role in training future skilled workers. This includes the creation of virtual laboratories, simulation models and robotic systems. The learning process can be gamified to motivate and create interesting tasks. It is also important to develop digital tutors, which will become an indispensable tool in education. Potential areas of artificial intelligence development in Ukraine should become the basis for creating competitive education. Financial investments in these programmes will yield good results in the future, and the training of specialists will meet the requirements of the modern labour market.

Conclusions

The study of the impact of artificial intelligence on the Ukrainian education system in the context of the Education 4.0 concept shows that there is a huge potential for its implementation and several challenges facing Ukraine. In the example of European countries, the introduction of artificial intelligence into the education system has shown its successful transformation. Applying pedagogical, synergistic and comparative methods allowed us to assess the state of modern Ukrainian and European education. The biggest challenges for Ukraine remain the Russian invasion and the lack of funding to introduce the latest technologies. There are few studies on the results of introducing artificial intelligence into modern Ukrainian education. Analysis of scientific sources has shown that artificial intelligence technologies are being actively introduced into the educational process in developed countries. In Ukraine, however, this process is at an early implementation stage due to lacking the necessary infrastructure and educational programmes for wider adoption. The study only confirmed the importance of introducing the latest technologies into the education system. Ukraine has every opportunity to implement these systems and create its initiatives based on the experience of European countries. In the future, developing guidelines for implementing artificial intelligence, training high-quality personnel, and creating conditions for a continuous safe environment are necessary.

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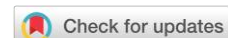


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.7>

Cómo citar:

Sosnova, M., Hlianenko, K., Sosnova, V., Tsyna, V., & Tsyna, A. (2025). Enhancing the effectiveness of learning through hybrid education methods. *Revista Eduweb*, 19(2), 95-106. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.7>

Enhancing the effectiveness of learning through hybrid education methods

Mejorar la eficacia del aprendizaje mediante métodos de educación híbrida

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Recibido: 02/05/25

Aceptado: 07/06/25

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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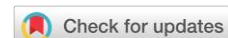


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.8>

Cómo citar:

Dryshliuk, V., Chanysheva, A., Borychenko, K., Kravchenko, S., & Hotsuliak, Y. (2025). Application of the practice of the ECHR in legal education: impact on the formation of judicial culture and the protection of human rights. *Revista Eduweb*, 19(2), 107-121. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.8>

Application of the practice of the ECHR in legal education: impact on the formation of judicial culture and the protection of human rights

Aplicación de la práctica del CEDH en la educación jurídica: impacto en la formación de la cultura judicial y la protección de los derechos humanos

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Recibido: 20/04/25

Aceptado: 06/06/25

Abstract

Given the growing role of international human rights institutions in the process of harmonizing national legal order with generally recognized human rights standards, there is an objective need to rethink approaches to legal education. The purpose of the study is to clarify the role of the practice of the European Court of Human Rights as a conceptual and applied element in the system of legal education, its influence on the formation of judicial culture and the development of professional legal awareness of future lawyers. The research methodology consists of the following methods: dialectical, formal-logical, comparative-legal and



structural-functional methods. The impact of the Court's decisions on the formation of a lawyer's professional identity was considered, in particular in the area of the formation of his law-enforcement culture, worldview orientation on respect for human rights and freedoms, the principle of the rule of law and the principles of independent and impartial judiciary. The need for systematic integration of the Court's case law into the curricula of higher legal education institutions was substantiated, which will contribute not only to the formation of deep theoretical knowledge, but also the ability to properly apply them in practice. Practice-oriented approaches to teaching international human rights standards as a tool for forming a judicial culture that meets the requirements of a legal state are analyzed.

Keywords: European Court of Human Rights, legal education, judicial culture, protection of human rights, rule of law.

Resumen

Dado el creciente papel de las instituciones internacionales de derechos humanos en el proceso de armonización del ordenamiento jurídico nacional con las normas de derechos humanos generalmente reconocidas, existe la necesidad objetiva de replantear los enfoques de la educación jurídica. El objetivo del estudio es aclarar el papel de la práctica del Tribunal Europeo de Derechos Humanos como elemento conceptual y aplicado en el sistema de educación jurídica, su influencia en la formación de la cultura judicial y el desarrollo de la conciencia jurídica profesional de los futuros abogados. La metodología de investigación consta de los siguientes métodos: dialéctico, lógico-formal, jurídico-comparativo y funcional-estructural. Se consideró el impacto de las decisiones del Tribunal en la formación de la identidad profesional del abogado, en particular en el ámbito de la formación de su cultura policial, su visión del mundo sobre el respeto a los derechos humanos y las libertades, el principio del Estado de derecho y los principios de un poder judicial independiente e imparcial. Se justificó la necesidad de integrar sistemáticamente la jurisprudencia del Tribunal en los planes de estudio de las instituciones de educación superior jurídica, lo que contribuirá no solo a la formación de conocimientos teóricos profundos, sino también a la capacidad de aplicarlos adecuadamente en la práctica. Se analizan enfoques orientados a la práctica para la enseñanza de los estándares internacionales de derechos humanos como herramienta para la formación de una cultura judicial que cumpla con los requisitos de un Estado de derecho.

Palabras clave: Tribunal Europeo de Derechos Humanos, educación jurídica, cultura judicial, protección de los derechos humanos, Estado de derecho.

Introduction

In the current conditions of globalization and legal integration, the issue of harmonizing the national legal order with international standards in the field of human rights protection is of particular relevance. The practice of the European Court of Human Rights occupies a central place in this system, which is an important source of interpretation of the provisions of the Convention for the Protection of Human Rights and Fundamental Freedoms of 1950 (hereinafter referred to as the Convention) (United Nations, 1950) and serves as a reference point for national law enforcement bodies. Ukraine, as a state party to the Convention and a party to the Vienna Convention on the Law of Treaties of 1969 (United Nations, 1969), is obliged not only to implement the decisions of the ECHR in specific cases, but also to take into account the established case law of the Court in all areas of the functioning of the legal system, including legal education.

Legal education, integrated with modern jurisprudence in the field of human rights, is a necessary prerequisite for establishing the principles of a democratic state based on the rule of law and is designed to provide professional training for lawyers capable of competently implementing international legal standards in the domestic legal order, taking into account the principles of the rule of law, legality and justice. In this context, the practice of the European Court of Human Rights acquires importance not only as a tool for normative interpretation of the provisions of the Convention, but also as a value basis for the



formation of a high level of professional legal awareness, ethical responsibility and judicial culture of lawyers.

The systematic application of the practice of the ECHR in legal education meets the urgent need to improve the quality of legal training in the light of international human rights standards. In the modern legal reality, when the decisions of the ECHR are increasingly becoming a catalyst for legislative changes and law enforcement transformations in Ukraine, the issue of their integration into educational courses, professional trainings and advanced training programs is of particular importance.

The laws of Ukraine, in particular Law 3477-IV (2006), directly oblige the state to ensure the execution of the decisions of the ECHR and take into account their practice in the domestic legal system. Draft legislation updating the High Council of Justice, as well as recommendations from such authoritative institutions as the Venice Commission and the OSCE, emphasize the need to strengthen judicial independence, the professional responsibility of judges, and the role of education in ensuring these tasks (Venice Commission, 2017).

Therefore, the problem of introducing the practice of the ECHR into the legal education system is not only academic, but one that is directly related to the formation of an effective, independent and human rights-protecting judiciary capable of meeting the challenges of a modern democratic society.

The object of the study is social relations arising in the field of professional legal education in the context of implementing the practice of the European Court of Human Rights as a tool for forming judicial culture and ensuring effective protection of human rights and freedoms.

The subject of the study is the theoretical, legal and applied aspects of integrating the practice of the European Court of Human Rights into the content of legal education, its methodological significance for the formation of legal awareness and professional ethics of future lawyers, as well as the impact on the establishment of standards of judicial culture in national law enforcement practice.

The objectives of the study are:

1. To determine the regulatory and legal basis and methodological guidelines for the use of the practice of the ECHR in the legal education system.
2. To investigate the substantive and functional significance of the practice of the ECHR for the formation of basic competencies of a lawyer in the field of human rights and to establish the relationship between the integration of ECHR decisions into the educational process and the level of formation of judicial culture in the state.
3. Analyze the impact of the ECHR practice on the transformation of legal education in accordance with the requirements of the rule of law.

This study constitutes an initial theoretical and normative analysis, the purpose of which is to critically substantiate the need to integrate the practice of the ECHR into Ukrainian legal education. Based on this framework, it is proposed to advance future research toward the design and implementation of specific pedagogical models that effectively achieve this integration.

Theoretical Framework and Literature Review

Analysis of modern scientific research demonstrates the growing importance of the practice of the European Court of Human Rights in shaping both law enforcement activities and educational strategies for training future lawyers. The integration of the practice of the ECHR into legal education is considered a key tool for strengthening the rule of law, raising standards for the protection of human rights and forming a new quality of judicial culture based on respect for international law. In this context, the works of a number of researchers who reveal various aspects of this issue were analyzed.

Rabinovych & Garasymiv (2015) focus on the normative and legal potential of the ECHR decisions in cases against Ukraine, in particular as a tool for identifying gaps in national legislation. The authors consider the ECHR as a body that performs the function of a negative legislator, forming the state's obligations to amend domestic law on the basis of established violations. This approach is relevant for substantiating the need to integrate the case law of the ECHR into courses on constitutional, administrative and public international law, as it allows students to develop an understanding of the mechanisms of the impact of court decisions on the legal system. At the same time, it should be noted that this work is limited to a normative and legal approach and does not cover the issue of the educational potential of the analyzed decisions.

The study by Zavgorodniy (2017) highlights the impact of the practice of the ECHR on the law enforcement activities of Ukrainian courts, in particular through the prism of the need to ensure compliance of domestic jurisdiction with European standards. It is emphasized that the recognition of the practice of the ECHR as a source of law necessitates the formation of skills among lawyers to interpret national legislation in the light of the decisions of this international court. These conclusions confirm the feasibility of including ECHR precedents in the content of training courses on judicial practice and law enforcement methodology. However, the study does not contain a detailed analysis of educational tools for implementing the practice of the ECHR in the training of future lawyers.

Mendez analyzes the experience of the human rights movement in Latin America, focusing on the transitions from authoritarianism to democracy, the role of lawyers, civil society activists, and educational initiatives in the protection of human rights. At the same time, the idea is revealed that the legal system should not only maintain order, but also be an instrument of emancipation and democratization.

Contribution to the study of legal education in Ukraine: This experience is especially valuable for Ukraine, which is in the process of reforming the judicial system, fighting corruption, and strengthening democratic institutions. Méndez emphasizes that legal education should form not only specialists, but also human rights defenders - an approach that can become the basis for revising the mission of law faculties in Ukrainian higher education institutions (Mendez, & Mariezcurrena, 2000).

Castro-Buitrago examined the development of clinical legal education in Latin American countries as a response to the lack of access to justice. The author shows how student legal clinics can simultaneously develop practical skills in students and provide legal assistance to vulnerable groups. The clinics are presented as a bridge between education and social justice. The example of Latin America shows that clinics can become a powerful tool of public interest - especially in the context of armed conflict, human rights violations, and internally displaced persons (Castro-Buitrago et al., 2010).

Fernández Fernández (2024) article examines how popular education (popular, non-institutional) in Latin America was used as a tool in the struggle for human rights, especially under dictatorial regimes. The author emphasizes the importance of education that focuses not only on the transfer of knowledge, but also on the formation of critical thinking, legal awareness, and active citizenship. Contribution to the study of legal education in Ukraine: This source demonstrates how legal education can go beyond the boundaries of classical classroom training and become an element of a broad social movement. For Ukraine, especially in the context of war, democratic transformation, and the struggle for the rule of law, this experience can be adapted in the form of informal legal education programs, mobile law schools, legal training for communities, veterans, internally displaced persons, etc.

Solotkyi (2018) analyzes the place and role of the ECHR decisions in the legal system of Ukraine, emphasizing their binding nature and law-making nature. The thesis is put forward about the priority of the ECHR practice in case of a conflict with national norms. This approach is extremely important for legal education, as it demonstrates to students an example of the hierarchy of sources of law in the context of European integration. However, the author does not reveal how this characteristic of decisions can be methodologically embedded in the teaching of legal disciplines.



Yurovska (2021) devotes her research to the study of the practice of the ECHR in the activities of the body of constitutional jurisdiction, that is, the Constitutional Court of Ukraine. The work argues that the practice of the Court of Luxembourg has become an integral part of Ukrainian constitutionalism, forming new standards of interpretation of human rights. Such an approach is valuable for the development of legal education in the field of constitutional law, as it demonstrates to students how international court decisions change the logic of legal understanding even at the level of higher judicial instances. The methodology of interpretation applied by the Constitutional Court, taking into account the positions of the ECHR, deserves special attention.

In the fundamental work of Viljanen (2008), the thesis about the role of the ECHR as not only a judicial body, but also a de facto developer of international law in the field of human rights is substantiated. The author substantiates the concept of a "living Convention", according to which the provisions of the European Convention on Human Rights should be interpreted dynamically, taking into account changes in society. It is this characteristic of the decisions of the ECHR that allows them to be used in legal education not as static norms, but as examples of the evolution of law through case law. We fully agree with this statement, because it meets the tasks of forming flexible legal thinking in future lawyers. Viljanen's work is conceptually important for the development of the methodology of teaching human rights, in particular with an emphasis on their dynamic nature and interdisciplinary approach.

Repetto (2013) in his study examines the issue of the interaction of the European Convention on Human Rights and the decisions of the ECHR with national legal systems, especially in the context of Italy. The author argues that the practice of the ECHR acquires constitutional significance, in particular when it comes to the interpretation of fundamental rights and freedoms. Repetto proposes a model of integration of the decisions of the ECHR through the concept of "constitutionalization of human rights", which goes beyond the formal subordination to international law, and instead aims at harmonizing European and national standards. This approach is extremely relevant for the formation of a legal culture in which future lawyers perceive the Convention and the practice of the ECHR not as an external source, but as a structural part of the constitutional legal order. We fully agree with this approach, because it is through legal education that it is possible to ensure the formation of a national lawyer as a participant in the European legal dialogue.

Syroid & Fomina (2023) analyze international legal standards of legal education in the field of human rights, in particular, referring to documents of the UN, the Council of Europe and the OSCE (2016). The work emphasizes the need to institutionalize human rights education in the training systems of judges, lawyers, prosecutors. Attention is drawn to the lack of a systematic teaching methodology, as well as the insufficient level of internationalization of the content of legal programs in Ukraine. The work is conceptually important for our study, as it allows us to substantiate the institutional need to include the practice of the ECHR in the professional training of lawyers. We fully agree with the thesis about the need for a systemic, rather than episodic, approach to human rights in the educational process.

The article by Kilián, Pospíšil & Smekal (2016) analyzes the place of international human rights law in legal education in the Czech Republic. The authors emphasize that although international standards are formally present in the curricula, their practical teaching is often reduced to a formal consideration of theoretical provisions without analysis of the practice of the ECHR or its application in case methods. A gap is noted between academic theory and judicial practice. These observations are also relevant for the Ukrainian context. We share the authors' criticism of the insufficient use of practice-oriented methods of teaching human rights and emphasize the need to strengthen the component of analysis of ECHR decisions in courses on international, administrative and constitutional law.

Eberbach's (2023) study examines the role of legal education in fostering a democratic legal culture in a context of political instability, using Myanmar as an example. The author shows that even in countries with authoritarian tendencies, human rights education can serve as a tool to support the standards of the ECHR and international law. Considerable attention is paid to teaching methods, in particular clinical education, interactive learning, and mock trials. Eberbach's work confirms that human rights education is not only a legal but also a cultural category. We support the author's approach to the active use of innovative teaching

methods that ensure the formation of a judicial culture even in crisis political contexts. At the same time, the excessive idealization of the possibility of legal education as a factor of democratization in states with unstable political regimes is somewhat controversial. We agree with the need to implement human rights even under authoritarian pressure, but we do not share the optimism that education alone without political will can transform judicial culture.

Grossman (2004) puts forward the idea of globalization of legal education, within which human rights should be a cross-cutting theme of the curricula. The author insists on the need for interdisciplinarity, international exchange and the mandatory integration of decisions of international courts into the educational process. The strategic role of law faculties in creating an environment that supports the rule of law and respect for human rights is emphasized. Grossman's ideas are the conceptual basis for the formation of our hypothesis about the central role of the practice of the ECHR in the formation of the legal consciousness of future lawyers. We fully agree with the criticism of the narrow-profile approach to legal education and support the proposed globalization vector.

The scientific and methodological manual by Fuley (2020) presents a systematic review of the practice of the ECHR in the field of administrative justice, in particular in cases on freedom of expression, the right to a fair trial, and the protection of property rights. The manual contains practical recommendations for judges on the interpretation of the provisions of the Convention in the light of case law. This work has direct practical significance for teaching subjects of the administrative law cycle. We agree with the author that without a thorough knowledge of the practice of the ECHR, high-quality implementation of administrative justice is impossible, and therefore, proper training of lawyers.

Zhigalkin (2024) analyzes the specifics of the use of the ECHR conclusions by the High Council of Justice in the context of bringing judges to disciplinary responsibility. The problem of uneven consideration of ECHR standards, as well as the interpretation of the integrity and independence of a judge through the prism of the practice of the Strasbourg Court, is highlighted. The work indicates the practical need in legal education to reveal to students the significance of ECHR decisions in the field of professional ethics of judges and disciplinary practice. We fully support this position, as it reveals the connection between theoretical knowledge about human rights and judicial behavior in real conditions. Indicators of the Ministry of Education Currently, Ukraine has a fairly wide network of educational institutions that train lawyers. It consists of 164 higher education institutions and 117 institutions of professional pre-higher education. In 2023, they graduated 2,408 professional junior bachelors, 2,143 junior specialists, 55 junior bachelors, 15,932 bachelors and 7,539 masters in the specialty 081 "Law". According to these indicators - the number of specialized educational institutions and the number of graduates - Ukraine significantly exceeds the average indicators in the member states of the European Union. For example, in Austria, only 6 universities train lawyers, in Spain - 14, and in Poland - 19. In contrast, in Germany, where there are 57 specialized institutions, an average of 8-10 thousand graduates acquire the profession of lawyer every year (Pravo-Justice, 2024). High-quality and corruption-free legal education remains crucial for strengthening the rule of law in Ukraine. Therefore, in the European Commission report within the framework of the EU Enlargement Package, published in November 2023, among the unresolved problems and, accordingly, tasks for Ukraine in the field of legal education are:

- Implementing a clear institutional demarcation of legal education and training specialists for law enforcement agencies;
- Strengthening requirements for access to legal education;
- Strengthening requirements for licensing and accreditation of higher education institutions that train lawyers;
- Ensuring a transparent and merit-based distribution of public funds for the training of lawyers;
- Modernizing educational programs in the specialty "Law" with an emphasis on legal ethics, practical training, studying EU law, ensuring international academic mobility, implementing a single state qualification exam, as well as strengthening the fight against corruption and plagiarism.



At the end of May, the Ministry of Education and Science (MES) approved the standard of professional pre-higher education in the specialty of Law by its order. In practice, this means continuing to train lawyers in colleges at the level of a professional junior bachelor. This contradicts the policy of the MES on optimizing the legal education system. The draft of the new list of specialties developed by the ministry cancels the training of lawyers at the level of professional pre-higher education, that is, in colleges.

Currently, the quality of legal education in many law schools does not meet the needs of the labor market. The number of graduates significantly exceeds the demand among employers. In particular, only 65% of law graduates find work, and not always in their specialty. Therefore, the MES has taken a course to optimize (reduce) the number of higher educational institutions (hereinafter referred to as HEIs) in general, including those that train lawyers (Order 762, 2024).

Colleges lack highly qualified teachers who can train relevant legal specialists. This is evidenced by the analysis of the results of the Unified Professional Entrance Examination (EFVV), which is an entrance exam for master's degrees. Law students who entered a bachelor's degree after graduating from college have worse results in passing the EFVV than graduates of a bachelor's degree in law who entered it immediately after school. Therefore, unfortunately, the education of law students in colleges is often reduced to a process for the sake of the result (obtaining a diploma). In 2018, there was an increase in absenteeism at the EVI and EFVV, in particular among graduates of law enforcement agencies and applicants aged 30 and over (every fourth one did not appear). Despite the stable level of threshold requirements compared to 2017, the share of those who did not pass the threshold increased due to the general weakening of the academic level of applicants.

Across the country, a decrease in both the minimum and average levels of legal knowledge of applicants for a master's degree in the specialty 081 "Law" was recorded. The main reasons for this phenomenon are: demographic factors, a decrease in the requirements of higher education institutions for applicants, as well as a decrease in the relative weight of the professional block in the structure of the competitive score (for example, a decrease in the threshold score from 31.4% in 2017 to 30% in 2018), while simultaneously increasing the requirements in the TZNPk and in a foreign language (Mudruk, 2019).

When comparing the results of the EVI and EFVV of graduates of the specialties "Law" and "International Law", a higher level of knowledge was revealed among representatives of the latter. The only exception was civil procedural law, where they demonstrated worse results, which is due to the peculiarities of educational programs. However, in the disciplines "Public International Law" and "International Protection of Human Rights", graduates of the specialty "International Law" had a significant advantage.

The study used thematically relevant sources selected through a targeted analysis of scientific literature on the topic of the study. The selection was carried out using leading academic databases, such as Scopus, Web of Science, Google Scholar and others, using keywords that corresponded to the main areas of the study. In doing so, the relevance of the publications, their scientific value, as well as their relevance to the selected issue were taken into account. This approach ensured thematic integrity and relevance of the sources, although it should be noted that the study does not claim to be completely systematic, but has the features of a targeted (narrative or integrative) review.

In general, a critical analysis of the sources indicates broad support for the idea of the need to introduce the practice of the ECHR into the legal education system. The main agreed positions are to recognize the practice of the Strasbourg Court as a factor in harmonizing legal systems, strengthening the rule of law and forming the professional ethics of future lawyers. At the same time, some debatable positions have been identified regarding the implementation of these ideas in specific educational and political contexts, which require further development within the framework of interdisciplinary research.

Methodology

The research methodology is based on the integrated application of four key methods: dialectical, formal-logical, comparative-legal, and structural-functional, which provides a comprehensive analysis of the issues of applying the practice of the ECHR in legal education, as well as its impact on the formation of judicial culture and the protection of human rights.

The dialectical method, based on the principles of development and contradictions in social phenomena, as well as on the identification of unity and struggle of opposites in the legal process, made it possible to study the formation of judicial culture and the protection of human rights as processes that are constantly changing, interacting and influencing each other. Using the dialectical method, the study analyzed the dynamic interaction between the norms of international law, in particular the Vienna Convention on the Law of Treaties (United Nations, 1969) and the Convention for the Protection of Human Rights and Fundamental Freedoms (United Nations, 1950), and the national legislation of Ukraine regulating the implementation of ECHR decisions (Venice Commission, 2017). Thanks to this approach, contradictions and the processes of overcoming them through the implementation of international standards in national law, which is the foundation for the development of a democratic legal state, were identified. The method made it possible to trace the evolution of legal education under the influence of the practice of ECHR as a factor in strengthening the rule of law and justice. In addition, a careful analysis of key decisions of the ECHR (Rekvényi v. Hungary (European Court of Human Rights, 1999a), Brumărescu v. Romania (European Court of Human Rights, 1999b), European Court of Human Rights (2011), Volkov v. Ukraine (European Court of Human Rights, 2013), Ovcharenko and Kolos v. Ukraine (European Court of Human Rights, 2023)) provides an opportunity to see how the Court shapes legal standards that have a direct impact on national judicial proceedings. This is especially true in areas such as the right to a fair trial, freedom of expression, the right to privacy and other fundamental rights.

The formal-logical method, based on the logical analysis of legal norms and concepts, the establishment of cause-and-effect relationships, the classification, systematization and formalization of legal phenomena, was applied for the systematic analysis and classification of the main legislative acts, regulatory legal documents and decisions of the ECHR, in particular, taking into account legislative changes. Thanks to the formal-logical method, it was possible to clearly determine the structure of legal norms, analyze the logic of their application in legal education and judicial practice, and establish mechanisms for implementing ECHR norms into the national legal system. This contributed to the formation of a clear understanding of the regulatory framework governing the use of ECHR practice and its role in law enforcement.

The comparative legal method, which consists in comparing the legal systems, norms and practices of different countries, was used to compare Ukrainian legislation and judicial practice with the norms of the Convention on the Protection of Human Rights and the practice of the ECHR, as well as with the legal systems of other European countries and the research of scientists. The comparative analysis made it possible to identify shortcomings and gaps in national legal education and judicial practice, as well as to propose specific ways of improvement based on the best European standards. At the same time, the role of the ECHR as a global arbiter in the field of human rights was established, which directly affects the reform of legal education and law enforcement in Ukraine. In addition, the comparative analysis provided an opportunity to critically assess existing methodologies in Ukraine and identify gaps that need to be eliminated. For example, Eberbach (2023) points to the challenges of legal education in countries with transitional systems, which is relevant for Ukraine.

The structural-functional method, which helps to study the structure of legal institutions and systems, as well as the functions they perform in society, determines their interrelation and role in the implementation of law, made it possible to analyze the functional role of legal education as a system for training specialists capable of applying the practice of the ECHR in the national context. It was studied how educational programs integrate the principles of the rule of law, legality and protection of human rights, which are enshrined in legislation and international documents. The method helped to highlight the main functions of



the judicial system in the legal provision of human rights protection through the implementation of the ECHR, as well as the role of legal education in the formation of judicial culture and professional ethics of future lawyers.

Results and Discussion

The application of the practice of the European Court of Human Rights in the legal education system of Ukraine has not only theoretical and practical, but also normative justification. The legal consolidation of the state's obligation to take into account the decisions of the ECHR as a source of law is a key factor in the formation of a judicial culture based on European human rights standards.

According to the Convention for the Protection of Human Rights and Fundamental Freedoms (United Nations, 1950), by which Ukraine undertook to ensure the rights and freedoms of everyone within its jurisdiction (Article 1), the final decisions of the ECHR are binding on the States Parties (Article 46) (United Nations, 1950). Ukraine's obligations to properly implement international treaties are also confirmed by the Vienna Convention on the Law of Treaties (United Nations, 1969), according to which "every treaty in force is binding on the parties to it and must be performed by them in good faith" (Article 26), and "a party may not invoke the provisions of its internal law as a justification for its failure to perform a treaty" (Article 27) (United Nations, 1969).

In the national legal framework, these obligations are specified by the Law of Ukraine "On the Execution of Decisions and Application of the Practice of the European Court of Human Rights" (Law 3477-IV, 2006), which explicitly states that "the Convention and the practice of the European Court of Human Rights are sources of law in Ukraine" (Article 2), and "courts shall apply the Convention and the practice of the Court as a source of law when considering cases" (Article 17) (Law 3477-IV, 2006).

Thus, the formation of a modern judicial culture in Ukraine is impossible without integrating the practice of the ECHR into the educational programs of law faculties. After all, only a systematic study of the content and legal approaches of the ECHR will allow future lawyers to effectively use the norms of the Convention as norms of direct effect, which is required by both the law and international obligations of Ukraine.

Today, in the context of Ukraine's European integration and the reform of the Ukrainian judicial system, the issue of integrating the practice of the European Court of Human Rights into legal education is becoming particularly relevant. As noted in the analytical material on the Lex platform (National School of Judges of Ukraine, 2021), in the context of the development of Ukrainian justice, the decisions of the ECHR have both a normative and educational function: they form the vector of judicial practice based on the principles of the rule of law, respect for human dignity, and effective protection of rights.

According to the OSCE (2017), the fundamental element for the formation of a lawyer's professional thinking is not only knowledge of the content of the ECHR decisions, but also understanding of their logic, systemic analysis and standards of evidence that the court applies in cases. Training courses developed within the framework of OSCE projects prove that the integration of ECHR practice into the process of teaching administrative, civil and criminal justice promotes the transition from formal interpretation of norms to law focused on the protection of the individual. Such a reorientation of lawyers' thinking has a systemic impact on the renewal of judicial culture in Ukraine.

The decisions of the ECtHR, according to the Council of Europe (2024), increasingly affect not only courts of general jurisdiction, but also local authorities, which also require a renewal of approaches in legal education. Considering the case-law of the ECtHR is an important tool for ensuring a balance between the State's margin of appreciation and its obligations under the Convention. For local authorities and law enforcement, this means an increased level of responsibility in the field of human rights, and for law faculties, the need to study the case-law of the ECtHR as a separate discipline or a cross-cutting element in other courses.

Studies (OSCE, 2017; Council of Europe, 2024) confirm that only if the case law of the ECHR is integrated into the curricula can we speak of full-fledged training of a lawyer of the European model. In this context, it is worth agreeing with the conclusions of the analytical material posted on the Lex platform (National School of Judges of Ukraine, 2021) regarding the need for systematic training of legal teachers who are able to convey to students not only the content of the ECHR decisions, but also the culture of human rights as the basis of legal awareness.

However, some aspects need to be considered critically. In particular, the sources mentioned do not always focus on the potential risks of a formalized approach to teaching the practice of the ECHR, when the study of decisions is limited to citing them without proper analysis of the context, circumstances of the case, legal conclusions and mandatory standards. Such an approach, although it declares the formal presence of topics of human rights in the educational process, in practice does not contribute to a deep understanding of the essence of Convention standards by students.

Thus, the practice of the ECHR plays a key role in the transformation not only of law enforcement activities, but also of legal education, becoming a catalyst for the formation of a qualitatively new judicial culture, based on the principles of the European legal tradition. The application of ECHR decisions in the educational process should be based on an interdisciplinary approach that combines theoretical foundations, analysis of precedents and simulations of court proceedings.

Modern legal education is undergoing a transformation from traditional formalism to an interdisciplinary model, where the understanding and application of international human rights standards play a key role. The study by Syroid & Fomina (2023) notes that the training of future lawyers should go beyond the national context and include international legal mechanisms for the protection of human rights, in particular the practice of the ECHR, as a practical tool for combating legal nihilism and formalism.

A similar position is expressed by Kilián, Pospíšil & Smekal (2016), who analyzed the Czech experience of integrating human rights into legal education. They emphasize that the practice of the ECHR is not only a subject of study, but also a methodological basis for teaching such disciplines as criminal procedure, administrative law and constitutional justice. Therefore, it can be agreed that the inclusion of the practice of the ECHR in the curricula ensures the formation of critical thinking and the training of specialists who are able to act effectively in conditions of legal uncertainty.

At the same time, as Repetto (2013) rightly notes, excessive focus on the case law of the ECHR without its proper interpretation in the national context may lead to legal “copying” rather than a deep understanding of the mechanisms of human rights protection. This thesis should be taken into account in the Ukrainian context, where legal education often demonstrates a tendency to dogmatically expound norms without an analytical component.

The impact of the ECtHR’s practice is not limited to the educational process, as case law has a direct impact on the formation of judicial culture — a set of ideas, values, and practices that determine the ethical and professional standards of judicial activity. Eberbach (2023), studying legal education in transitional countries, proves that teaching human rights through ECHR cases changes students’ legal consciousness and lays the foundation of a lawyer’s professional identity focused on serving society. Grossman (2004) shares a similar view, emphasizing that global legal education should take into account the different legal systems in which the ECtHR operates as an instrument of cultural internationalization of legal norms. Such an approach certainly deserves support, as it allows future lawyers to understand not only the formal content of legal decisions, but also the social, political, and moral consequences of their application.

A separate place in modern research is occupied by the analysis of the impact of the practice of the ECHR on the institutions of disciplinary liability of judges in Ukraine. Zhigalkin (2024) reasonably draws attention to the problem of selective or formal application of ECHR decisions in the activities of the High Council of Justice (HCJ). The author emphasizes that, despite the direct binding nature of the Court’s conclusions,



they often do not find a systematic and consistent reflection in the decisions of disciplinary bodies. Such an approach not only violates the guarantees of the independence of judges, but also jeopardizes trust in the judicial system as a whole, which negatively affects the image of the rule of law (Zhigalkin, 2024).

For example, the case law of the ECHR has repeatedly clearly defined the criteria for the admissibility of interference with the activities of judges. In particular, in the cases of *Volkov v. Ukraine* (European Court of Human Rights, 2013), *Ovcharenko and Kholos v. Ukraine* (European Court of Human Rights, 2023) and *Serkov v. Ukraine* (European Court of Human Rights, 2011), the Court emphasized the need to observe the principles of fair trial and legal procedure, which should guarantee the independence and impartiality of judges (European Court of Human Rights, 2013; European Court of Human Rights, 2023; European Court of Human Rights, 2011; European Court of Human Rights, 2024). According to these norms, disciplinary prosecution of judges must be justified, proportionate and subject to thorough legal review so as not to violate the right to a fair trial.

Of particular importance is the judgment in *Brumărescu v. Romania* (European Court of Human Rights, 1999b), in which the ECtHR stressed that interference with final court decisions undermines the principle of legal certainty, which is a basic feature of the rule of law. The Court stressed that disciplinary sanctions that may affect the autonomy of judges must strictly comply with the standards of the European Convention on Human Rights (European Court of Human Rights, 1999b). These standards are becoming guidelines for reforming Ukrainian judicial disciplinary practice, which still faces problems of politicization and formalism.

The problem lies in the lack of a unified methodology and systematic approach to the implementation of the ECHR case law in disciplinary proceedings against judges. As a result, the selective application of ECHR decisions in the disciplinary practice of the Supreme Court of Justice creates legal uncertainty and undermines the authority of the judicial system, which is critically dangerous for ensuring the rule of law in Ukraine (Zhigalkin, 2024). To overcome these challenges, it is important to strengthen the role of legal education and advanced training of judges and members of the Supreme Court of Justice, taking into account the requirements of the ECHR. Educational programs should include a systematic study of ECHR decisions, analysis of typical problems and practical recommendations, and contribute to the formation of a judicial culture focused on respect for international standards for the protection of human rights.

Thus, the integration of the practice of the ECHR into legal education is not only a pedagogical or educational and methodological innovation, but also a necessary component of the transformation of legal culture in general. Its significance lies in the fact that it forms a new generation of lawyers capable of acting in the spirit of international standards, protecting human rights and ensuring the informal but sustainable development of the rule of law. However, this integration must be systemic, critical and adapted to the national context, which requires reforming approaches to legal education, improving the qualifications of teachers and updating methodologies.

One of the main problems is the insufficient level of integration of ECHR decisions into the curricula of law schools. As the Organization for Security and Co-operation in Europe (OSCE) notes, there is a need to develop and implement standardized courses based on ECHR case law to improve the skills of judges and lawyers (OSCE, 2017).

Ways to solve the problem may be as follows:

1. Curriculum development: Creation of courses covering the main aspects of the ECHR practice, taking into account the specifics of national legislation.
2. Teacher training: Conducting trainings and seminars for law faculty teachers to familiarize them with the practice of the ECHR and its teaching methods.
3. Cooperation with international organizations: Involvement of OSCE and Council of Europe experts in the development of training materials and holding joint events.

Integrating the practice of the ECHR into legal education contributes to the formation of a judicial culture focused on the protection of human rights and compliance with international standards. As noted by the Council of Europe, local and regional authorities play a key role in ensuring human rights by providing basic public services such as housing, healthcare, education and social security (Council of Europe, 2024). The application of the practice of the ECHR in legal education allows future lawyers to better understand the mechanisms of human rights protection and use them effectively in their professional activities. This contributes to raising the standards of human rights protection in Ukraine and bringing the national legal system closer to European standards (Council of Europe, 2024).

Thus, ensuring the proper application of the practice of the European Court of Human Rights in the field of disciplinary liability of judges is one of the key factors in the formation of a modern judicial culture based on the principles of the rule of law and guarantees of the independence of justice. Taking into account and systematically implementing the standards of the ECHR contributes to improving the quality of law enforcement activities, reducing the risks of politicization of the judiciary and strengthening public trust in judicial institutions. At the same time, to effectively solve existing problems, it is necessary to comprehensively reform not only the regulatory framework but also approaches the education and training of judges and members of disciplinary bodies, taking into account international standards.

The integration of the practice of the ECHR into legal education is an important prerequisite for the formation of the consciousness of future lawyers who are able not only to apply international norms, but also to develop national legislation in accordance with the requirements of European law. Such an educational approach contributes to the emergence of a new generation of lawyers and judges with a high level of professionalism, capable of ensuring the sustainable development of the rule of law and effective protection of human rights in Ukraine.

Conclusions

As a result of the research conducted on the impact of the application of the practice of the ECHR in legal education on the formation of judicial culture and the protection of human rights, the following conclusions were drawn.

The analysis of regulatory legal acts, in particular the Convention for the Protection of Human Rights and Fundamental Freedoms (United Nations, 1950), the Law of Ukraine "On the Execution of Decisions and Application of the Practice of the European Court of Human Rights" (Law 3477-IV, 2006), as well as relevant judicial practice, confirms the presence of clear obligations of Ukraine to implement the decisions of the ECHR into the national legal system. At the same time, methodological guidelines for the integration of the practice of the ECHR into legal education are formed on the basis of the priority of international human rights standards and the rule of law. It has been determined that the key regulatory basis for the implementation of the practice of the ECHR into the educational process is not only direct legal acts, but also approaches that form the system of professional competencies of future lawyers taking into account European standards for the protection of human rights. However, there is a need to further improve the legislative framework and develop specialized methodological materials to ensure a holistic approach to teaching international human rights law in national educational institutions.

A substantive analysis of the practice of the ECHR reveals it as a key tool for the formation of professional and ethical competencies of a lawyer focused on the protection of human rights and freedoms. The practice of the Court serves as a source of legal norms and a foundation for the development of critical thinking, the ability to apply international standards in the context of national law and understanding the functional role of the court in a democratic society. It has been established that the systematic integration of ECHR decisions into curricula contributes to the formation of a judicial culture based on the principles of impartiality, fairness and openness of justice. It is emphasized that the absence or formal nature of the inclusion of ECHR practice in the educational process negatively affects the readiness of future lawyers to effectively implement



European standards of justice at the national level, which, in turn, slows down the process of developing the rule of law in the state.

It has been established that the practice of the ECHR stimulates the reform of legal education and forms new methodological approaches that correspond to the concept of the rule of law as the basic principle of a modern legal state. The study found that updating the content of curricula through the inclusion of current decisions of the ECHR improves the quality of professional training, ensuring a deeper understanding of international legal norms and their application. At the same time, we analyze the problems of insufficient unification of educational standards, the lack of practice-oriented courses and the limited availability of specialized resources, which complicates the full adaptation of national legal education to European requirements. The scientific conclusion is that the transformation of education in this area requires a systematic approach that will include both updating curricula and improving the qualifications of teachers, and developing integrated methods for teaching international human rights law with an emphasis on practical application.

The results of the study allow us to conclude that the integration of the practice of the European Court of Human Rights into legal education serves as a conceptual basis for the formation of a new paradigm of professional legal training. This approach contributes to the assimilation by students of substantive and procedural standards of human rights protection and the formation of an internal judicial culture focused on the values of legal democracy, impartial justice and effective access to legal protection. Accordingly, the practice-oriented study of the decisions of the ECHR within the educational process is a necessary prerequisite for the training of specialists capable of ensuring the implementation of European human rights standards at the national level.

Further Scientific Research

Regarding further scientific research, we consider it necessary to pay attention to assessing the effectiveness of legislative and institutional reforms aimed at implementing ECHR standards, including through the prism of educational programs and law enforcement practice.

An important area of research is to analyse the relationship between legal education and the rule of law. It would also benefit from a more systematic study of its own access to justice efforts. To what extent are students actually reached by clinics, pro bono programmes, core courses and internships or externships? How do students, alumni, and experts in the field assess the effectiveness of current curricula and programme initiatives?

In the absence of external evaluation, it is easy for schools to conflate good intentions with good results. Empirical evidence can be a useful tool against complacency and a source of educational innovation.

This agenda invites the legal academy to rethink its social justice responsibilities. Certainly, the country with the highest concentration of lawyers can better serve those who need it most. To make this possible, lawyers must do more to educate themselves, their students and the public about systemic deficiencies in legal services. If an academy is serious about instilling the values of equal justice in its students, its own priorities should reflect this.

This study is limited by its reliance on secondary sources and the lack of empirical data, such as surveys or interviews, which restricts the ability to assess the practical impact of integrating ECHR case law into legal education. Additionally, it does not fully explore regional differences in implementation or offer in-depth comparative analysis with other European legal systems. These limitations suggest the need for further research based on fieldwork to evaluate how effectively ECHR principles are being taught and applied in Ukraine's legal education and judicial practice.

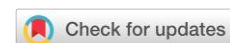
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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.9>

Cómo citar:

Kostolovych, M., Yaroslavtseva, M., Pyekharyeva, S., Bykova, M., & Radchenko, L. (2025). Development of creative competence in university students through information technologies: an experimental study. *Revista Eduweb*, 19(2), 122-142. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.9>

Development of creative competence in university students through information technologies: an experimental study

Desarrollo de la competencia creativa en estudiantes universitarios a través de las tecnologías de la información: un estudio experimental

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Recibido: 30/04/25

Aceptado: 02/06/25

Abstract

The article reveals the content of the concept and the main indicators of creative competence. The article aims to verify the developed and research-based pedagogical conditions for training specialists for the



formation of creative competence in professional activity using information technologies. Regarding the research methodology, we used quantitative methods of data analysis. This group of empirical research methods includes obtaining information about the object under study that allows us to identify its quantitative characteristics. When determining the sample of subjects, the general specificity of the research subject was considered. The total sample size was 120 subjects. When forming the sample, the criteria of content, representativeness, and equivalence were taken into account. As a result of the experimental work, according to all the specified criteria and indicators, a positive dynamic of creative competence was formed due to the use of modern information technologies among EG students, which confirms the significant influence of the specified pedagogical conditions on the preparation of students for the manifestation of creative competence in professional activities.

Keywords: professional training, modern information technologies, professional activity, students, formation of creative competence.

Resumen

El artículo revela el contenido del concepto y los principales indicadores de la competencia creativa. El objetivo del artículo es verificar las condiciones pedagógicas desarrolladas e investigadas para la formación de especialistas en el desarrollo de la competencia creativa en la actividad profesional mediante el uso de tecnologías de la información. En cuanto a la metodología de investigación, se emplearon métodos cuantitativos de análisis de datos. Este grupo de métodos de investigación empírica incluye métodos para obtener información sobre el objeto de estudio que permiten identificar sus características cuantitativas. Al determinar la muestra de sujetos, se tuvo en cuenta la especificidad general del sujeto de investigación. El tamaño total de la muestra fue de 120 sujetos. Al formar la muestra, se tuvieron en cuenta los criterios de contenido, representatividad y equivalencia. Como resultado del trabajo experimental, de acuerdo con todos los criterios e indicadores especificados, se formó una dinámica positiva de la competencia creativa debido al uso de tecnologías de la información modernas entre los estudiantes del GE, lo que confirma la influencia significativa de las condiciones pedagógicas especificadas en la preparación de los estudiantes para el desarrollo de la competencia creativa en las actividades profesionales.

Palabras clave: formación profesional, tecnologías de la información modernas, actividad profesional, estudiantes, formación de la competencia creativa.

Introduction

Today, the task of higher education is not only to increase the level of professional competence of graduates, but also to form a mobile, creative, socially stable personality, able to adapt to modern conditions, ready for self-development, and effective application of this knowledge in professional activities. Based on this, in the formation of creative competence of students through the use of modern information technologies, an important role is assigned to higher education, which aims to reveal the personality of a person; to educate in his interest in acquiring knowledge, in the educational field; to form a modern citizen adequate to modern life, possessing innovative high-quality knowledge (Harashchuk & Kutsenko, 2022).

The need of the present is to improve the preparation of students for the formation of creative competence in professional activity through the use of modern information technologies, which is based on innovative teaching of creative technologies. Therefore, comprehensive education and training of specialists who have the skills of adaptation to changing conditions, high creative potential, and skills to meet the requirements of the labor market is one of the fundamental tasks of the education system.

Thus, the question arises of the need to optimize the educational process, find new ways and means of forming creative competence, apply effective innovative technologies, and create favorable conditions for the realization of students' creative abilities. In this regard, there is a growing need to develop innovative teaching methods that are implemented within the framework of educational models that are creative and



ensure an increase in the quality of higher education as a whole. This is precisely what determines the relevance of the article (Kalinina, 2017).

Practice shows that, for example, when using information technologies in education, such as text information, the intensity of learning is 20-25%, and when using sound media, this figure increases to 45-50%, while when using them together (text, sound and video information) – 70-75%. The use of information and technical achievements in education increases the effectiveness of the educational process, arousing students' interest in working with modern equipment, thus increasing their motivation for learning; expands the possibilities for presenting information through the use of multimedia; provides access to learning sources – databases, knowledge bases; provides flexibility of learning strategies, etc.

Analysis of theoretical developments of scientists on the development of competencies using information technologies in terms of the formation of creative competence in them made it possible to state several contradictions between:

- Global trends that actualize the need for a creative approach to the problems of modern high-tech production, which increases the requirements for the quality of training of specialists, and the insufficient orientation of educational institutions on the development of creative competence of future specialists as an integral characteristic of their effective performance of professional functions;
- The desire of university students to be competitive in the labor market and their insufficient understanding of the significance of the formation of creative competence as a personal and professional characteristic of a sought-after specialist;
- Teachers' awareness of the importance of forming in students a readiness to actively demonstrate creative competence in future professional activities, and the insufficient development of pedagogical conditions and means of their implementation concerning the specified competence.

Therefore, the study of the process of developing creative competence of future specialists is a relevant and important task that meets the requirements of the modern social environment and professional standards.

The relevance of the problem raised, the theoretical and practical benefits of its solution, its insufficient development in pedagogical science, as well as the need to eliminate the identified contradictions, determined the choice of the topic of the article.

Literature Review

An appeal to the scientific discourse of recent decades shows that the problem of creativity, creative abilities, and creative thinking is widely represented in the works of foreign and domestic scientists.

Several scientists distinguish a separate type, creative giftedness, as the potential of an individual and their readiness for creative activity. One of the new scientific perspectives is the study of creativity, the ability to make innovative decisions, critical thinking in the context of classification and explanation of "soft skills" as important skills of the 21st century. Analysis of the works of Klocho, Nagayev, Kovalenko & Fedorets (2020) shows that "man has always strived for creative self-expression". Creative abilities are considered by scientists as those that "correspond to general giftedness, that is, they are prerequisites for highly effective intellectual activity". Authors proved that "during the creative process, the harmonization of the personality as a system occurs, and in the act of creation, a person is freed from previous tension. As a result of tension relief, harmonization occurs between the elements of the system".

Among the studies of giftedness and creativity, many works reveal the psychological properties that characterize a gifted, creative person. The main place in the preparation of specialists for the formation of creative competence in professional activity is occupied by the development of the creative potential of giftedness. Methodological, scientific-theoretical, and applied aspects of the formation of creative



competence in the professional activity of future specialists are considered by Harashchuk & Kutsenko (2022). Scientists revealed the components of creative resources (intellectual abilities of a person, the personality itself, environment, knowledge, thinking style and motivation), which contribute to the ability of a future specialist to integrate knowledge, to the formation of developed professional thinking at different functional levels; they substantiated the principled approaches to the formation of creative specialists, the essence of competence and competence of an employee in the educational sphere, ways to develop motivation in a future specialist to master quality knowledge, to study. In the psychological and pedagogical discourse, there is a fairly wide range of research devoted to various aspects of creativity as an important feature of every teacher. We share the position that every stage of pedagogical activity should be carried out based on creativity, and creativity should "permeate" all components of the educational process. The problems of forming creative competence of students in higher education are considered by Kalinina (2017). At the same time, students' abilities to be creative are a component of professional competence and an important professional quality of the personality. "It is substantiated that the use of information technologies in the educational process contributes to the formation of creative competence of university students".

In recent years, pedagogical creativity has been considered within the framework of the implementation of the competency-based approach, which is actively developed in modern theory and is gradually being introduced into the practice of educational institutions. This problem is considered in the article by Sokół, Figurskab, and Blašková (2015). The main scientific goal of the article by these scientists is to study and investigate the frequency of Internet use in the educational process in selected higher educational institutions using scientific procedures and appropriate methodology to determine the impact of online learning on the competencies of professional creativity of human capital. The results obtained became the basis for formulating the research hypothesis: the higher and more developed the ability to use the Internet in the educational process, the higher the level of competencies of professional creativity of human capital, which as an element of intellectual capital is an important factor of development at the micro- and macro-regional levels.

The variety of innovative technologies includes Internet technologies, which involve the interaction of all participants in the educational process, which is carried out using methods that activate pedagogical communication, as an equally active intersubjective interaction. Innovative technologies help to intensify independent creative work, which contributes to the development of creative skills and cognitive activity. In particular, the scientist Norqulov (2024) in the article explores the formation of creative competence in students through the integration of innovative technologies in education. It emphasizes the importance of creative competence, which is defined as the ability to generate new ideas, solve problems, and adapt to new situations, which is crucial for success in the 21st century. The article examines various innovative technologies, such as multimedia tools, virtual and augmented reality (VR and AR), artificial intelligence (AI), and digital platforms, emphasizing their role in improving students' learning experiences and developing creativity.

A thorough analysis of research on this issue allows us to conclude that in the process of training specialists, more attention should be paid to the formation of creative competence through the use of modern information technologies, the formation and development of students' creative activity, the development of creative abilities, imagination, fantasy, skills, etc.

Paying tribute to the scientific achievements of the listed researchers, taking into account the realities of today, there is a growing need to continue scientific research in terms of developing theoretical and methodological foundations and developing practical recommendations for the development of creative competence in university students using information technologies. Therefore, clarifying the essence of creative competence, conducting an analysis of the state of development of the labor market and higher education in Ukraine, monitoring the employment and career growth of graduates, and developing ways to develop creative competence in university students using information technologies requires a comprehensive solution to these problems.

The theoretical significance and practical necessity of developing creative competence in university students using information technologies, insufficient scientific and applied development of these issues, determine the relevance of the problem and the choice of the topic of the article, outlining its purpose and structure.

PURPOSE OF THE ARTICLE. Verification of the pedagogical conditions developed and substantiated in the research for the training of specialists for the formation of creative competence in professional activity using information technologies.

Methodology

To achieve the set goal, a set of research methods was used at the following stages of the study:

- *Theoretical*: to highlight the state of the research problem – analysis of scientific literature; to clarify the state of development of concepts of the research issue – synthesis, generalization, comparison, systematization of theoretical data;
- *Empirical*: pedagogical experiment, observations, conversations, questionnaires to determine the level of formation of creative competence through the use of modern information technologies;
- *Mathematical statistics*: for mathematical processing of diagnostic data, establishing the reliability of conclusions, and determining the significance of results.

When determining the sample of subjects, the general specificity of the research subject was taken into account. The total sample size was 120 subjects. The control group contained 60 respondents, and 60 in the experimental group. When forming the sample, the criteria of content, representativeness, and equivalence were taken into account. The sample was formed by random selection using the technical procedure of calculating the selection step.

The implementation of the pedagogical experiment was carried out in three stages: preparatory, main, and final.

At the preparatory stage, the purpose and objectives of the study were determined, the experimental plan was developed, methods of measurement and processing of the results were identified, control and experimental groups were selected, and their homogeneity was checked.

At the main stage, the experiment was conducted.

At the final stage, the results of the experiment were analyzed, their reliability was confirmed, and conclusions were drawn about the pedagogical effect of the experiment.

The experiment was conducted during 2023-2024.

The experiment involved bachelor's degree students in socio-economics who are in their 1st-3rd year of university.

The experiment was conducted in Rivne State University of Humanities, Municipal Establishment «Kharkiv Humanitarian-Pedagogical Academy» of Kharkiv Regional Council, Sumy State Pedagogical University named after A. S. Makarenko, National University of Life Resources and Environmental Management of Ukraine. The conduct of the experiment is permitted by the scientific councils of the universities in order not to violate ethical considerations in institutions of higher education.

The reliability and validity of the obtained results, the objectivity of their assessment were ensured by the methodological justification of the initial positions and the qualimetric mechanism for assessing the quality



under study, the use of a complex of complementary research methods, and the involvement of a group of respondents from a higher educational institution in the analysis of its results.

To assess the homogeneity of the experimental and control data collection, statistical processing was carried out using MS Excel and SPSS (Statistical Package for Social Science) programs.

In our article, we used quantitative methods of data analysis. This group of empirical research methods includes methods of obtaining information about the object under study that allow identifying its quantitative characteristics.

We have implemented pedagogical conditions for creative competence in university students using information technologies.

The first condition was the creation of a creative environment using ICT.

The choice of technologies was based not only on the requirements of society, but also on the individual characteristics of the student. Expressive means of digital resources (computer graphics, video clips) open up opportunities to stimulate the emotional perception of educational messages, this is achieved through figurative vision, emphasizing the main idea in the frame, dynamic editing, etc. Currently, the term "visual thinking" is becoming increasingly widespread, which is defined as "human activity, the product of which is the generation of new images, the creation of new visual forms that carry a certain semantic load and make knowledge visible."

Increasing the creative activity of students in the educational process using digital resources is determined by the following motives:

- Exceptionally wide possibilities of digital resources for individualizing education;
- Providing a wide field for active, independent activity of students;
- Ensuring a wide area of contacts; the ability to communicate via the Internet with any person, regardless of their spatial location and time zone differences;
- High clarity of presentation of educational material, especially when modeling phenomena in dynamics, demonstrating fast-moving and very slow processes (the possibility of time transformation), volumetric or, conversely, microscopic objects (the possibility of space transformation);
- Growing interactive capabilities;
- Accessibility;
- Multiple acceleration and reduction of the mass of routine operations (for example, such as the production of volumetric calculations, graphing, modeling phenomena, documenting the results of learning and research, etc.).

The second pedagogical condition is the development of the student's creative potential, which stimulates creative activity through the use of various types of digital resources. These are: purposeful creation of conditions and stimulation of the creative process for each student; creation of open learning situations, consideration of alternative points of view and approaches; creation of conditions for eliminating conformism; creation of a positive emotional background for learning, and elimination of stress factors in classes. Using educational platforms (such as Moodle, Google Classroom) in experimental groups.

The third pedagogical condition is the creation of a special course. The special course is aimed at the practical mastery of creative practices that form individual and socially oriented technologies in the development of a teacher's creative competence. Practical mastery of creative technology groups will contribute to the preparation of socially active, creative, creative specialists in the field of information technologies in the process of advanced training, capable of self-improvement, self-determination, and self-actualization with the skills of individual and team creative activity. In the process of gradual mastery of the special course, students should realize: the role and importance of the creative component in the formation

of an innovative education system and the heuristic potential of the introduction of innovative technologies for the formation and development of creative competence.

These pedagogical conditions not only provide an opportunity for a student at each educational level to develop their original creative potential, but also awaken the need for further self-knowledge, creative self-development, and form an objective self-esteem in a person.

Results and Discussion

The content of the concept and the main indicators of creative competence, qualities that are distinguished in the structure of the creative competence of the individual.

The activity, the result of which is the creation of spiritual and new material values, is creativity. Creativity has procedural, personal, and psychological aspects and assumes the presence of knowledge and skills, motives, and abilities in the individual, thanks to which the creative product is created and is distinguished by uniqueness, originality, and novelty (Dermendjieva & Tsankov, 2023). The study of such personality properties revealed the important role of fantasy, intuition, and imagination as unconscious components of mental activity, as a person's need to expand and reveal their creative capabilities, in self-actualization (Kalinina, 2017).

We support the opinion of Ziaziun (2011) that "creative competence is a complex personal formation that includes intellectual, emotional, moral and other acquired knowledge, skills and abilities, which allows, at a fundamentally new, integrative level, to transfer acquired competencies from one sphere of life to another, to achieve a fundamentally new result of activity or perform activity at a fundamentally new qualitative level".

A creative personality is distinguished by a high level of development of motivation for creativity, is characterized by the formation of a wide range of qualities and properties, has a high level of intellectual development, is characterized by independence and originality of judgments, developed fantasy and imagination, richness of the inner world, sensitivity to the unusual and new, intuitive foresight, self-confidence, a developed "I" concept and ingenuity and initiative. The manifestation of these qualities and properties of a person indicates the formation of the creativity of the individual, a high level of personal development (Tkachenko, 2014).

The main indicators of creative competence are: innovative, informational, creative, research competence, because it is the curiosity of the mind, search activity that characterizes a creative personality, and finding and searching for an effective and new solution – the innovative orientation of a specialist who has creativity, that is, the necessary potential (Ho & Shih, 2023).

So, creativity is the ability to deeply understand one's experience, the ability to find solutions in non-standard situations, the ability to learn and be surprised, and the ability to discover something new (Puhach et al., 2021).

The creative competence of a modern specialist includes a system of personal qualities, skills, abilities, and knowledge, which are necessary for creativity. The creative component can be in any type of pedagogical, organizational, or communicative activity of a person. The emphasis is, in this context, on the research component of a person's professional activity (Illyakhova, 2018).

Let's highlight the qualities that are distinguished in the structure of the creative competence of the individual. These are:

- The ability to solve problem tasks, to be creative, flexibility, ingenuity, critical thinking, self-confidence, and originality of a person, intuition; the ability to solve and set non-standard tasks, the ability to transfer experience, the ability to synthesize, analyze, combine, predict, etc.;
- Emotional and imaginative qualities;
- Emotional uplift in a creative situation; the ability to empathize (empathy), associativity, spirituality, a sense of novelty, imagination, sensitivity to contradictions;
- Overcoming stereotypes; insight, the ability to see the familiar in the unfamiliar; the desire for freedom, a tendency to take risks (Shetelya et al., 2023).

Analyzing creative abilities, let's determine the properties inherent in a creative personality and identify criteria for assessing a person's ability to think creatively and exhibit innovative personality traits.

Analyzing creative abilities, we will define the properties inherent in a creative personality:

- High level of scientific talent;
- Spontaneous curiosity;
- Tendency to ask questions;
- Interest in the complex and incomprehensible;
- Sense of responsibility for the development of science;
- Ability to spend a long time solving one problem (Lu et al., 2022).

Let's list the possibilities of scientific talent that involve the development of a personality:

- The ability to reproduce and remember a large amount of information for a long time;
- The creative thinking of a person.

You can use the criteria for assessing the individual's ability to think creatively:

- The degree of complexity of the mental task that the student solves and the speed with which the person solves mental tasks;
- Imagination – the ability to imagine something new visually that has not been encountered before in experience. Imagination plays a particularly important role in phases of scientific research, such as building and testing a hypothesis, a thought experiment (Shyshkin, 2016).

In addition to scientific talent, for the success of scientific research work, a student must have innovative personality traits:

- Diligence – the ability to work long hours;
- Discipline;
- The ability to criticize and self-criticize;
- Enthusiasm for one's work and its tasks;
- The ability to communicate with people (Savchenko et al., 2024).

The task of higher education is to activate the creative potential of the student during the educational process and to develop in future specialists of innovative digital technology the formation of creative competence by the requirements of modern society (Todorova, 2024).

Signs and principles that characterize creative education. The role of self-movement, self-affirmation, independent work, self-improvement, self-education, self-knowledge, self-regulation, self-determination, and self-realization in preparing students for the formation of creative competence in professional activity through the use of modern information technologies.

Let us name the features that characterize creative education: orientation towards the development of the creative potential of educational technologies, systematic construction of the educational process, positive motivation for creativity, balance of practical skills and theoretical knowledge, diversity of teaching methods, continuous development of knowledge and problem-solving, active participation in the formation of students' educational programs (Fedulova & Shovkun, 2009).

Active use in education of computer laboratory workshops, activities of training modules and cases, electronic tests and textbooks, demonstration materials, multimedia presentations, virtual business games, electronic full-text textbooks, multimedia training programs is important in preparing specialists for the formation of creative competence in professional activity (Knysh et al., 2024).

Proper management of educational development risks contributes to their successful use by adhering to the following principles:

- Successful combination of the technical component of education and the humanitarian component of education;
- Openness to all segments of society and accessibility of education;
- Implementation of applied scientific and fundamental research;
- Implementation of factors and their search, compliance with which contributes to the reduction of dangers and risks of losses (Vanutelli et al., 2022).

All this has a positive effect on the acceleration of the innovative economy, on the formation of a socially-oriented, creative economy, where education, in particular digital, plays a decisive role precisely in the formation of a society of happy people, and not just creative individuals (Harashchuk & Kutsenko, 2022).

Organization of experimental work.

In order to verify the pedagogical conditions developed by us and substantiated for preparing students for the formation of creative competence in professional activity through modern information technologies, we organized a pedagogical experiment that included the traditional stages for pedagogical research: ascertaining, forming. The experiment was held in the natural conditions of the university educational process.

At the stage of ascertaining the experiment, the goal was set to clarify the state of the problem of forming creative competence in students through the use of modern information technologies and readiness to reveal creative competence in their future professional activity. A questionnaire was conducted, in which 120 students – future specialists in socioeconomic specialties, studying in the 1st-3rd years of universities, participated.

In the structure of students' creative competence, we consider it appropriate to distinguish the following components: motivational, cognitive, activity, and reflective. We believe that the interaction of these components encompasses knowledge and skills, personality traits necessary for the professional preparation of university students to demonstrate creative competence in professional activities.

We have determined the criteria and indicators of the formation of creative competence in students through the use of modern information technologies and readiness to demonstrate creative competence in their future professional activities, during the study.



Motivational criterion.

Indicators: creative motivation (for professional realization – the need to be creative, the presence of motives that actualize creativity); creative attitude to the future profession (awareness of the need to demonstrate creativity in the profession, value orientations).

Personal criterion.

Indicators: creative potential of the student's personality (intuition, imagination, curiosity, originality, sense of humor and optimism, creative problem solving, emotionality); reflective skills (skills of self-organization and self-realization, skills and abilities of self-analysis and analysis of the collective creative activity of the group, one's own creative activity).

Cognitive criterion.

Indicators: effectiveness of knowledge (nature and completeness of knowledge), that is, the presence of knowledge of basic creative techniques and their innovative application in practice; features of the manifestation of creative thinking (adequacy, flexibility, originality, speed) in the field of informatization of education, which make the existence of creative activity possible; associative thinking (verbal creativity); divergent thinking (non-verbal creativity).

The formation of these criteria determines the readiness of future specialists to identify creative competence through the use of modern information technologies and the manifestation of readiness to apply creative competence in their future professional activities.

We have identified three levels of assessment of the formation of students' creative competence for each criterion: high, medium, and low.

We began the diagnosis of the level of formation of creative competence of university students using the motivational criterion.

At the ascertaining stage of the study:

- 18% of respondents from the CG and 19% of respondents from the EG have a high level of motivation for success;
- 39% of representatives of the CG and 39% of the EG have an average level of motivation for success;
- 43% of the CG and 42% of the EG have a low level of motivation for success.

Table 1.

Students' motivation for success

Groups	Levels		
	High	Average	Low
KG	18	39	43
EG	19	39	42

As a result, at the ascertaining stage:

- 20% of students from the CG and 19% of students from the EG have a high level of motivation for success in terms of the general indicator of attitude to the future profession;
- Low level according to the general indicator of attitude to the future profession, that is, unawareness of the need to obtain knowledge and skills and the importance of creativity in professional activity and insufficient desire to demonstrate creative abilities in the field of informatization of education, the lack

of need to creatively solve professional tasks was demonstrated by 44% of respondents in the CG and 40% of respondents in the EG.

Table 2.

Motivation for success by general indicator of attitude towards future profession

Groups	Levels	
	High	Low
CG	20	19
EG	44	40

In the aggregate of all indicators of the motivational criterion, a high level was demonstrated by 19% of respondents in the CG and 19% of respondents in the EG. Thus, the low and approximately equal initial level of formation of creative competence in the field of informatization of education, according to the motivational criterion of university students, was confirmed using objective diagnostics.

Identification of the level of development of reflectivity and creative potential in future specialists was provided by the diagnostics of the personality criterion.

A high level of personal creativity is inherent in a student who has developed creative potential, is persistent, proactive, active, can use innovations, independence, willingness to take risks, emotionality, a sense of humor and optimism, which contribute to providing the creative process with positive emotions, etc.

According to the results of the ascertaining experiment:

- A high level was found in 32% of respondents in the CG and 33% of respondents in the EG;
- A low level of personal creativity was shown by 29% of respondents in the CG and 29% of respondents in the EG. A low level is characteristic of a student whose creative potential is not sufficiently developed, who lacks initiative and passive participation in professional activities, and who is prone to obeying the majority opinion.

Table 3.

Results of the ascertaining experiment

Groups	Levels	
	High	Low
CG	32	29
EG	33	29

The survey at the ascertaining level revealed the following results:

- A high level of reflectivity, adequacy of self-assessment of creative potential, ability to reflect on activities, ability to think about one's activities, carefully plan them, and predict possible consequences was demonstrated by 17% of respondents in the CG and 20% of respondents in the EG,
- An average level of reflectivity was demonstrated by 44% of respondents in the CG and 45% of respondents in the EG,
- A low level was demonstrated by 39% of respondents in the CG and 35% of respondents in the EG.

Table 4.*Levels of reflexivity, adequacy of self-assessment of a student's creative potential*

Groups	Levels		
	High	Average	High
CG	17	44	39
EG	20	45	35

Diagnostics of the cognitive criterion at the ascertaining level involved determining the features of the manifestation of creative thinking, the manifestation of knowledge in the informatization of education, and identifying in students the initial level of effectiveness of knowledge necessary for the formation of creative competence, and showed the following results:

- A high level of creative competence was shown by 28% of the CG respondents and 30% of the EG respondents,
- An average level was shown by 37% of the CG respondents and 36% of the EG respondents,
- A low level of creative competence was shown by 35% of the CG respondents and 34% of the EG respondents.

Table 5.*Diagnosis of the cognitive criterion at the ascertaining level*

Groups	Levels		
	High	Average	High
CG	28	37	35
EG	30	36	34

Thus, the vast majority of the EG and CG respondents, according to this criterion, showed a generally insufficient level of readiness to reveal creative competence.

Quite low results were found for almost all indicators, which indicates the need to develop and implement pedagogical conditions to increase the level of formation of all indicators of the identified criteria of readiness to reveal creative competence of students as a whole.

The data from the ascertaining experiment allowed us to determine the guidelines with the students of the EG during the formative stage of the experiment.

At the formative stage of the experiment, pedagogical conditions for preparing students for the formation of creative competence in professional activity through the use of modern information technologies were developed and implemented in the EG:

- The first pedagogical condition: creating an educational, creative environment through the use of modern information technologies in the process of professional training;
- The second pedagogical condition: developing the creative potential of the individual in the process of professional training, which is aimed at: predicting consequences, creative production of ideas; developing originality of thinking, flexibility, speed, thoroughness in finding solutions to problems; developing a creative approach to interaction, developing critical thinking;
- The third pedagogical condition – implementing training and a special course on the formation of creative competence to develop the creative potential of students, ensuring the influence of a creative educational environment.

Analysis of the effectiveness of the results of experimental work at the formative stage of the study.

At the formative stage (2023–2024), the developed pedagogical conditions for training university students to form creative competence in professional activity through the use of modern information technologies were implemented; monitoring of the implementation of pedagogical conditions, quantitative and qualitative analysis of results using mathematical statistics methods, formulation of research conclusions were carried out.

Let us present the results of the formative stage of the experiment

By motivational criterion (Fig. 1):

- In the EG, the number of people who showed a high level of creative motivation increased by 12%, and the number of students with a low level decreased by 26%.
- In the CG, there were no such significant changes: the number of respondents with a high level of creative motivation increased by only 0.9%, and the number of respondents with a low level of creative motivation decreased by 3%.

The changes that occurred after the implementation of the developed pedagogical conditions are shown by the analysis of the dynamics of the formation of the creative attitude of university students to the profession by the motivational criterion:

- In the EG, the dynamics of the formation of the creative attitude of university students to the profession by the motivational criterion increased at a high level by 10%, and the number of respondents who showed a low level decreased by 25%;
- In the CG, the percentage of high-level formation of creative attitude of university students to the profession by the motivational criterion increased by 2%, and the percentage of respondents with a low level of formation of creative attitude of university students to the profession by the motivational criterion decreased by 3%, which is significantly lower than the similar indicator in the EG.

The positive changes that occurred in the motivational criterion during the experimental study were the result of the introduction of the first pedagogical condition into the educational process.

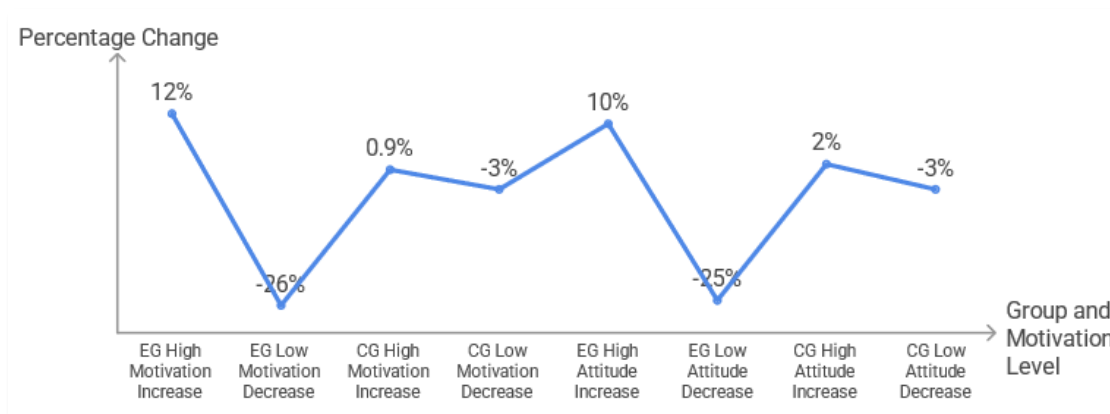


Fig. 1. Results of the formative stage of the experiment (by Motivation criterion).

By the personal criterion (Fig. 2).

Further diagnostics of the state of formation of creative competence in students by using modern information technologies took place according to the personal criterion.

In the personal criterion, the dynamics of changes occurred, which showed that:

- In the EG, the number of students with a high level of creative potential development increased by 9%, and the number of this same group of students whose level of creative potential development remained at a low level decreased by 20%;
- In the CG, the dynamics of a high level of creative potential development increased by 2%, and of a low level of creative potential development increased by 4%.
- In the CG, the number of students who showed a high level of reflection development increased by 10%, and the number of students who showed a low level decreased by 22%;
- In the CG, the percentage of high levels of reflection development in students increased insignificantly by 3%, and the number of respondents with a low level decreased by 7%, which is significantly less than the similar indicator in the EG.

During the experimental study, it was found that in the personal criterion, positive changes are caused by the introduction of two pedagogical conditions for the formation of creative competence into the educational process.

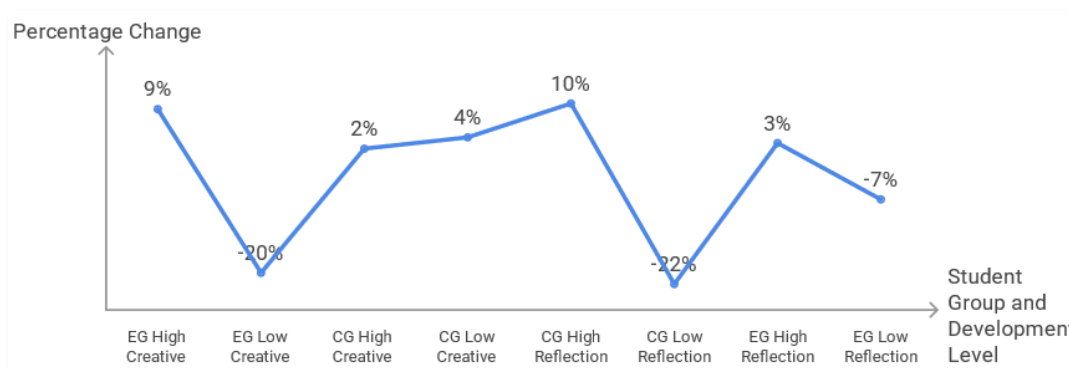


Fig. 2. Results of the formative stage of the experiment (by Personal criterion).
By the cognitive criterion.

In the course of the study, we will analyze the changes that occurred during the formation of the cognitive criterion indicators.

In the experimental group (Fig. 3):

- 1) The high level of divergent thinking development in students increased by 10%, and the number of respondents with a low level decreased by 18%;
- 2) The high level of associative thinking development in students increased by 7%, and the number of respondents with a low level decreased by 19%;
- 3) The high level of the behavioral creativity indicator increased by 9%, and the number of respondents with a low level decreased by 21%.

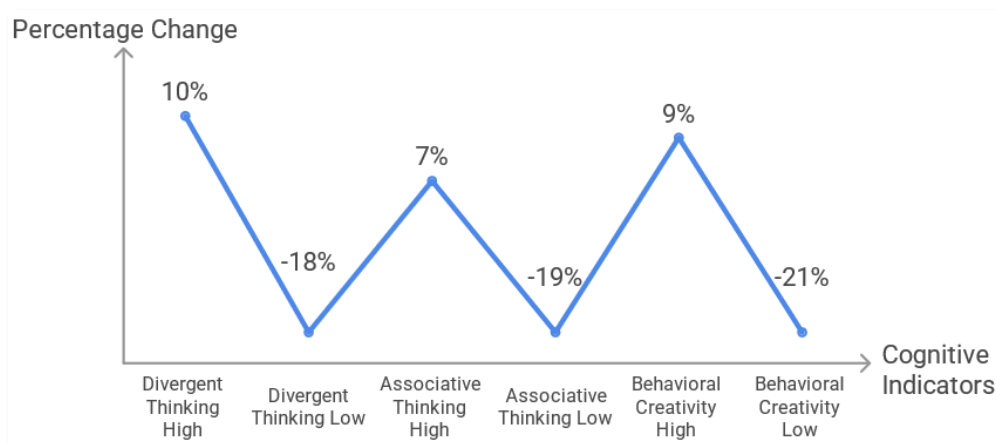


Fig. 3. Changes in cognitive criterion indicators (EG).

In the control group, the dynamics of changes in the cognitive criterion indicators did not become significant (Fig. 4):

- The high level of divergent thinking development in students increased by 2%, and the number of respondents with a low level decreased by 4%;
- The high level of development of associative thinking of students increased by 0.9%, and the number of respondents with a low level decreased by 3%;
- The high level, according to the indicator of creativity of behavior, increased by 2%, and the number of respondents with a low level decreased by 4%.

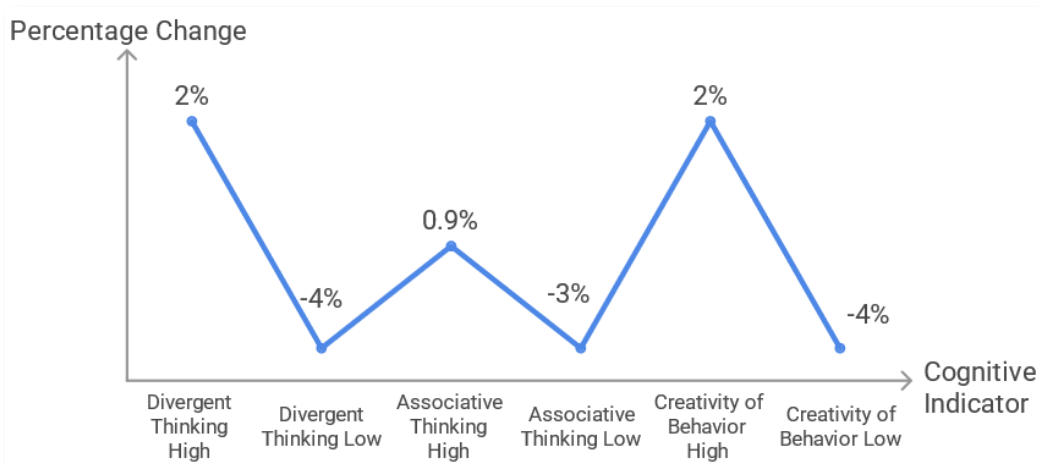


Fig. 4. Changes in cognitive criterion indicators (CG).

According to the indicators of the cognitive criterion, we observe the general dynamics of changes (Fig. 5):

- The number of EG students at a high level of knowledge effectiveness increased by 16%, and the number of respondents whose level of knowledge effectiveness remained at a low level decreased by 30%;
- Respectively, 3% and 6% of CG students observe the dynamics of high and low levels of their knowledge effectiveness.

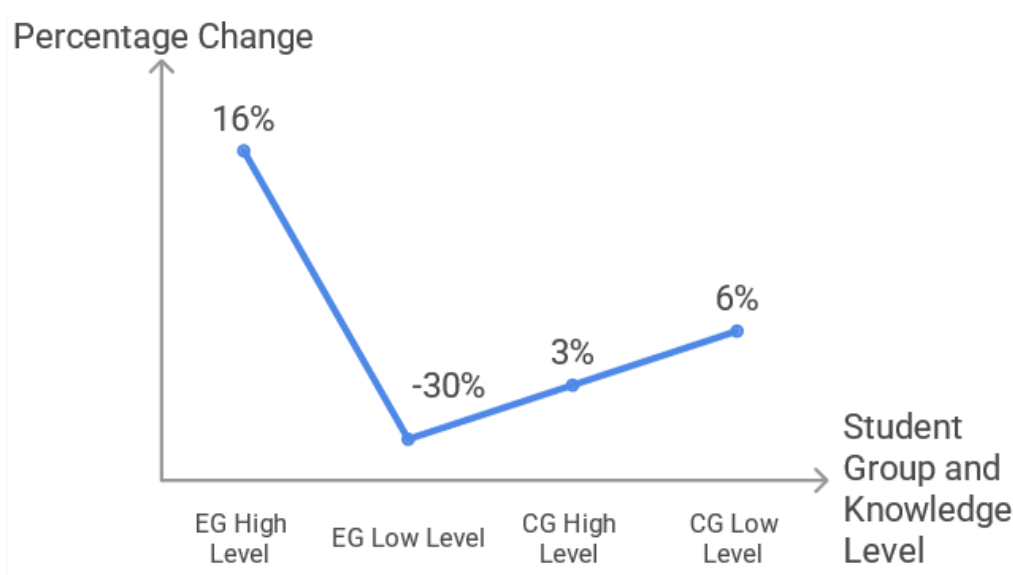


Fig. 5. General dynamics of changes (by the cognitive criterion).

Thus, according to all the specified criteria and indicators, a positive dynamic of creative competence was formed through the use of modern information technologies in EG students, which confirms the significant influence of certain pedagogical conditions on the preparation of students for the manifestation of creative competence in professional activity.

The results of mathematical statistics confirmed the study of the effectiveness of the implementation of the developed pedagogical conditions for training students of socio-economic specialties to identify creative competence in professional activity.

The null hypothesis was formulated: the distribution under consideration corresponds to the normal law. Alternative hypothesis: the distribution under consideration does not correspond to the normal law. All hypotheses are tested with a confidence probability of 0.95, that is, with a risk of 5%.

After the implementation of the pedagogical conditions developed by us for training students to form creative competence in professional activity through the use of modern information technologies, the arithmetic mean increased in all indicators of the identified components of creative competence in the EG, and the CG the changes were insignificant (unlike the control group, the percentage of respondents with high levels of indicators increased in the experimental group). This indicates the effectiveness of the pedagogical conditions that have been experimentally tested.

Statistical analysis methods were used to distinguish random fluctuations from significant changes.

Using the Student's t-test statistics, the change in the difference between the two mean values was analyzed. The hypothesis about the normal distribution is accepted for all four criteria of indicators, and we can use the Student's t-test.

For EG and CG, we formulate the hypotheses: null and alternative.

H0 – the null hypothesis is that: the difference in the mean indicators of the experimental (control) group – two sets of objects is insignificant for $k = N1 + N2 - 2$ degrees of freedom before and after the application

of the methods, i.e. the high level of formation of creative competence in EG respondents is explained by random factors.

H1 – alternative hypothesis is that: the difference between the average indicators of the experimental (control) group – two sets of objects is significant for $k = N1 + N2 - 2$ degrees of freedom before and after the application of the methods, that is, it is the introduction of pedagogical conditions that proves the high level of formation of creative competence in students in EG.

H0 – the null hypothesis is accepted, that is, for all criteria of indicators, the mathematical expectations of EG and CG do not have a statistical difference. That is, the indicators of students of both groups, EG and CG, before the experiment are statistically the same.

We find – all indicators are greater than the critical value. We conclude that the difference between the average values of the levels of formation of creative competence in university students through the use of modern information technologies in the experimental group is statistically significant. And the difference between the contingent of the experimental group before and after the implementation of the methods, that is, between the two populations, is significant and not accidental.

This fact is the basis for accepting the alternative hypothesis for the experimental group and rejecting the null hypothesis.

Comparison after the experiment of the indicators of CG and EG students suggests that they differ significantly. We argue that experimental training is successful, and these positive changes occurred thanks to it, given that after the experiment, EG students have higher average indicators.

Let us describe the consideration of the change in the distribution frequencies after the experiment. The statistical hypothesis that we are testing is “EG and CG have the same probability distribution” and the alternative: “EG and CG have different probability distributions”.

We used the Pearson consistency criterion (dichotomous criterion), comparing the relative frequency of the control group, which has a “high level”, only the relative frequency of the experimental group, which has a “high level”.

We determine the relative frequency of participants who have a high level in all indicators. We calculate the empirical value of Fisher's criteria. As a result, we obtain 0.722. We compare the empirical value of 0.722 with the critical value of the statistic 1.64. Thus, we accept the null hypothesis – H0. There is no difference before the experiment between the two statistical distributions of the two groups (EG and CG) of the relative frequencies of the number of students with “high level” indicators. This means that before the experiment, both groups (EG and CG) did not differ statistically in the considered indicators. Similarly, we continue the calculations for respondents with average and low-level indicators.

As a result, we obtain the measurable value of Fisher's criterion for low and high levels of the experimental group more than the critical tabular value, 247, that is, the creative competence of students after the experiment in EG is statistically significant and has changed positively (the share of low level has decreased statistically significantly, and the share of high level has increased statistically significantly). For low and high levels of the control group, we obtain a less critical tabular value of Fisher's criterion. Thus, the creative competence of respondents in the control group has not changed significantly.

Therefore, we can conclude that the results obtained are statistically significant.

In order to compare the differences between the groups before and after the introduction of a special course in the EG, which was aimed at developing creative competence in university students for the practical

mastering of creative practices using information technologies, the following statistical analysis was used: Student's t-test and Fisher's exact test.

The Student's t-test and Fisher's exact test are statistical tests that we used to compare the groups – EG and CG. Student's t-test was used to compare the mean values between the groups, and Fisher's exact test was used to compare the difference (dispersion) between the groups.

Comparing the mean values of two samples is one of the tasks in our study of the verified phenomenon of EG and CG. We solved this problem using Student's t-test (t-test). In particular, the null hypothesis is tested, which is that in the EG and CG both samples from the same general population were formed, that is, the differences are not caused by the action of the studied factor and are random between the mean values of the compared samples. The Student test belongs to the group of parametric analysis methods, therefore its correct application required the fulfillment of the following three conditions:

- Both samples must be independent (the properties of one of the samples must not be related to the properties of the other sample);
- Both samples must have a normal distribution law or one close to it;
- Homogeneity of variances (there must be no statistically significant difference between the dispersions of the samples).

Let us show the procedure for checking the significance of the coefficient by Student's t-statistics:

1. We choose the significance level of 1 or 5%.
2. We calculate the number of degrees of freedom.
3. Determine the critical value t for α , $n - k$, where $k = m + 1$, and m is the number of factors according to the Student distribution table. The critical value of the Student t-statistic was chosen for $\alpha = 0.05$ and $\gamma = (n - 2) = 16 - 2 = 14$ degrees of freedom. 2.145 – is equal to its value.

The calculated value of the t-statistic in absolute value is greater than the table value, therefore the correlation coefficient calculated for the selected significance level is significant for us.

We used Fisher's test in the study, because the test statistic of this criterion when performed is reduced to the ratio (sums of squares divided by "degrees of freedom") of the sample variances. The denominator and numerator were independent random variables, and the corresponding sums of squares had a Chi-square distribution. The statistic had a Fisher distribution, because our data had a normal distribution. In addition, the variance of the random variables whose squares are summed is the same. At a given significance level, a test was performed by comparing the value of the statistic with the critical value of the corresponding Fisher distribution.

Using the p-value – $p(F)$, a convenient way to test hypotheses, the probability that, with a given Fisher distribution, a random variable will exceed a given value of the statistic. We assumed that if $p(F)$ (for a two-sided test – $2p(F)$) is less than the significance level α , then the null hypothesis is rejected, and otherwise this hypothesis is accepted. When testing hypotheses, two cases of sample variances are possible: the variances are unequal or equal. In this regard, we had the task of testing the hypothesis of the significance of two variances – their differences. In general populations, to test the hypothesis of the equality of two variances, we used Fisher's exact test, which is based on two sample adjusted variances, their ratio, which in general populations replace the values of the variances. Using special tables, we found the critical values of Fisher's exact test for the corresponding number of degrees of freedom and a given significance level.

Scientific novelty of the study.

Comparing the results of various literary sources, the scientific novelty of our article is that we have for the first time identified and theoretically substantiated organizational and pedagogical conditions that positively affect the formation of creative competence in professional activities using information technologies

(motivation and stimulation of the value attitude of future digital technology specialists to the formation of creative competence; taking into account the educational aspects of using network services based on information technologies.

Practical significance of the study.

The practical significance of the study lies in the practical implementation of organizational and pedagogical conditions of creative competence in professional activities using information technologies and the implementation of a special course aimed at the development of creative competence in university students for the practical mastery of creative practices using information technologies that form individual technologies and socially oriented technologies in the development of a student's creative competence.

Conclusions

The content of the concept and the main indicators of creative competence are revealed; the qualities that are highlighted in the structure of the creative competence of the individual are highlighted; the creative abilities of the individual are analyzed, the properties inherent in the creative personality are determined and the criteria are identified to assess the individual's ability to creative thinking, informatization of knowledge, and innovative personality traits.

In order to verify the pedagogical conditions developed by us and substantiated for preparing students for the formation of creative competence in professional activity through the use of modern information technologies, we organized a pedagogical experiment that included the stages traditional for pedagogical research: ascertaining and formative. The experiment took place in the natural conditions of the university educational process.

The following components were identified in the structure of students' creative competence: motivational, cognitive, activity, and reflective.

We determined the criteria and indicators of the formation of students' creative competence through the use of modern information technologies and readiness to reveal creative competence in their future professional activities, during the study.

We determined three levels of assessment of the formation of students' creative competence for each criterion: high, medium, and low.

The results of mathematical statistics confirmed the study of the effectiveness of the implementation of the developed pedagogical conditions for the preparation of students of socioeconomic specialties for the identification of creative competence in professional activity.

Limitations of the study. The implementation of the pedagogical experiment was carried out in three stages during 2024-2025: preparatory, main and final.

Research relies heavily on the accuracy and reliability of data. The following digital data collection tools were useful in the study: MS Excel and SPSS (Statistical Package for Social Science) programs.

The total sample size in the article is 120 respondents. The sample of respondents was formed by random selection using the technical procedure for calculating the selection step.

During the experimental study, diagnostic data on the levels of social competence of higher education applicants were determined through informational influence and were divided into a control group (60 students) and an experimental group (60 students).



The research was implemented through the use of methods and various forms: multimedia technologies (projector, multimedia board, video and audio equipment), software that combines animation, graphic, text, video and sound data and information, their simultaneous use in the information space; mobile devices, personal computers, web-based resources that are freely available and free of charge (YouTube, author's website, specialized sites, social networks, social network technologies), etc. The limitations of this study allowed to have the following impact on the results: improved quality characteristics of the material, optimally specified goals and objectives, increased effectiveness of the results.

Future research directions. The issue of organizing the international activities of a modern university requires further study, primarily specifying priority areas and current tasks of innovative activities in the context of the internationalization of higher education.

Future research directions can be used to study the effectiveness of combined teaching methods that combine traditional and innovative approaches, as well as the impact of individual learning trajectories on student success. It is worth investigating the use of artificial intelligence in the development of creative competence in students, analyzing the long-term consequences of the use of virtual simulations, and developing approaches to improving social and communicative skills in combination with innovative teaching tools.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.10>

Cómo citar:

Duque, E., Medina, N., Navarro, M., & Rodríguez, M. (2025). Uso de las tecnologías de la información en el aprendizaje de los estudiantes de postgrado. *Revista Eduweb*, 19(2), 143-156. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.10>

Uso de las tecnologías de la información en el aprendizaje de los estudiantes de postgrado

Use of information technologies in learning among graduate students

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Recibido: 12/03/25

Aceptado: 15/06/25

Resumen

La presente investigación tuvo como objetivo analizar el uso de TIC como herramienta de aprendizaje de los estudiantes de Postgrado de Obstetricia y Ginecología de la ciudad Hospitalaria Enrique Tejera. Bajo un enfoque cuantitativo de tipo descriptivo, con un diseño no experimental de campo. La población estuvo conformada por 42 residentes estudiantes de Postgrado. La muestra fue de tipo censal. Para la recolección de la información se utilizó la encuesta y como instrumento se elaboró un cuestionario con catorce (14) preguntas dicotómicas. Validado por expertos y para su confiabilidad se usó el Coeficiente de Kuder-Richardson. Teniendo como resultado 0,73. La información fue analizada a través de la estadística descriptiva generando como conclusiones que, las TIC como estrategia de aprendizaje en estudiantes de postgrado de Obstetricia y Ginecología en la CHET, son ampliamente utilizadas para acceder a materiales de estudio, participar en cursos y Webinar, además colaborar en comunidades académicas, mejorando la interacción entre estudiantes y profesores, favoreciendo el aprendizaje colaborativo. Sin embargo, persisten retos en cuanto al acceso y habilidades tecnológicas, subrayando la necesidad de mejorar las competencias digitales.

Palabras clave: Tecnologías de la información y comunicación, herramienta de aprendizaje, estudiantes.



Abstract

This research aimed to analyze ICTS as a learning tool among Obstetrics and Gynecology graduate students at the Enrique Tejera Hospital City. The study used a descriptive, quantitative approach and a non-experimental field design. The population consisted of 42 graduate student residents. The sample was census-based. A survey was used to collect data, and a questionnaire with fourteen (14) dichotomous questions was developed as an instrument. Experts validated the questionnaire, and the Kuder-Richardson coefficient was used for reliability. The result was 0.73. The information was analyzed using descriptive statistics, leading to the conclusion that ICTs as a learning tool among Obstetrics and Gynecology graduate students at the University of Chechnya (CHEC) are widely used to access study materials, participate in courses and webinars, and collaborate in academic communities, improving interaction between students and faculty and fostering collaborative learning. However, challenges persist regarding technological access and skills, highlighting the need to enhance digital competencies.

Keywords: information and communication technologies, learning tools, students.

Introducción

Actualmente el desarrollo científico y de las nuevas tecnologías, así como los cambios producidos a partir de la pandemia de COVID 19, exigieron un replanteamiento del proceso educativo, en todos los niveles educativos, entre ellos el universitario, para poder cumplir con la formación académica rompiendo así con las barreras del distanciamiento social. En tal sentido, las prácticas digitales y competencias tecnológicas se han vuelto cada vez más importantes en el ámbito educativo y social. Actualmente, las tecnologías de la información y comunicación (TIC) son elementos de desarrollo en todos los aspectos de la vida moderna: económico, financiero, salud y educación. Existiendo en estas últimas distintas alternativas utilizadas como recursos para el aprendizaje con la posibilidad de llegar cada día a mayor cantidad de personas en diferentes escenarios. De esta forma, por ser fuente de información, herramientas de aprendizaje, evaluación y formación, adaptables y asequibles, las TIC son cada vez más frecuentes en todos los niveles educativos, pero especialmente en el nivel superior. Al respecto (López-Catalán et al., 2019), señalan “la formación de profesionales está cambiando en cuanto al uso de las herramientas digitales y el avance vertiginoso de las TIC”. (p.2).

Ahora bien, en el campo de la salud han permitido en algunos países el surgimiento y desarrollo de redes de telemática especializadas en educación médica continúa centrada en el estudiante, también el autoaprendizaje de manera innovadora y motivadora. Un ejemplo de ello lo indica, (Casillas & Gremeaux, 2012), al expresar “los estudiantes de 2do ciclo de medicina de la Universidad de Dijon en Francia encuentran utilidad en el uso de una página web de rehabilitación cardiovascular en la mejora de la adquisición de sus conocimientos a corto plazo” (p. 29).

En este orden de ideas, es preciso resaltar que, la sociedad se beneficia con las TIC de múltiples formas sobre todo en la educación, un ejemplo de esto, lo sucedido en tiempos de pandemia, donde los estudiantes no podían asistir a las universidades, debido a la cuarentena y distanciamiento social, esto hizo que profesores y estudiantes buscaran otras herramientas de aprendizaje para superar estas dificultades, facilitando la evaluación de los estudiantes en modalidad remota, empleando diversos recursos digitales para realizar exámenes en línea, tareas virtuales y evaluaciones formativas.

Por otra parte, la Organización de las Naciones Unidas para la Educación, Ciencia y Cultura (UNESCO, 2023) estableció estándares de competencia en TIC para docentes con la finalidad de mejorar la educación. Se dictaron una serie de directrices entre las que destaca un programa detallado de competencias destacando el papel de gran importancia de las tecnologías de la información y comunicación en la educación para hacer que las mismas se incluyan entre los conocimientos que deben adquirir los ciudadanos del siglo XXI. Es importante subrayar que las habilidades digitales y competencias tecnológicas se han vuelto cada vez más importantes en el mundo actual, y el uso efectivo de las TIC



puede preparar a los estudiantes para enfrentar los desafíos del siglo XXI. Al respecto expresa La UNESCO “que por medio de las TIC los estudiantes pueden adquirir las capacidades necesarias para llegar a ser: competentes para utilizar TIC, buscadores, analizadores, evaluadores de información, usuarios creativos de las TIC como herramienta de productividad” (p.1).

Cabe considerar que, en Latinoamérica la educación médica se basa en el contacto directo con los pacientes en conjunto con el docente, (docencia- asistencia) a diferencia de otros continentes que combinan la educación virtual y presencial para la adquisición de conocimientos y habilidades. Durante la pandemia de COVID-19, actualmente catalogada como endemia se retrasó la formación de los profesionales de las ciencias de la salud tanto de pregrado como postgrado en las áreas de conocimiento, habilidades y destrezas debido a las restricciones para impartir clases presenciales, es ese momento coyuntural adquieren mayor importancia las TIC, presentándose como una solución debido al cierre de centros educativos.

En Venezuela las prácticas educativas actuales en las ciencias de la salud requieren ser renovadas a los fines de destacar su papel para crear o construir saberes y de esta forma adquirir competencias de los futuros profesionales de la salud. Estas tecnologías representan una excelente opción para continuar de forma regular con el proceso de formación del personal y retomar las rutinas de trabajo que van de la mano con el aprendizaje en las ciencias de la salud. Al respecto, Chinchay-Vergara (2021), destaca el papel del aprendizaje activo en la educación médica durante la pandemia de COVID-19, quien subraya el cómo estas metodologías mejoraron la experiencia de aprendizaje fomentando nuevos enfoques pedagógicos. De este modo, se presenta el aprendizaje en el área de obstetricia- ginecología y en las ciencias de la salud en general, con una característica muy importante y básica, como lo es la presencialidad, el contacto directo con el paciente a través de su valoración clínica, a diferencia de médicos de otros países, los cuales reciben ciertos entrenamientos por medio de simuladores clínicos a distancia y de esa manera adquieren las capacidades necesarias para diagnóstico y tratamiento del paciente. En consecuencia, las características arriba descritas, provocan en cierto modo, algo de aversión o resistencia por algunos estudiantes renuentes al uso de TIC como instrumento aprendizaje, posiblemente debido al desconocimiento en el manejo, poca disponibilidad de dispositivos y servicio de internet en hospitales que pudieran ser causa de exclusión y desigualdad en las evaluaciones, posibilidad de sustituir el docente por un ordenador o una nube, pueden ser fuente de distracción que aleje a los estudiantes de sus competencias, reducción del rendimiento académico y disminución de las habilidades técnicas y manuales del médico obstetra ginecólogo.

En el caso específico de los residentes de ginecología y obstetricia de la Ciudad Hospitalaria Enrique Tejera (CHET), quienes se muestran; falta de familiaridad o habilidades técnicas, así como también escasa experiencia en el uso de las TIC, prefiriendo en muchas oportunidades el uso de los métodos tradicionales, lo que pudiera concebirse como un cambio en la forma en que se ha realizado siempre la educación médica, lo que puede generar inseguridad ante lo desconocido.

Referentes teóricos

La fundamentación teórica de esta investigación se centró en la teoría del constructivismo de Vygotsky, (citado por Riviére, 2002) la cual esboza que el constructivismo “surge como una teoría histórica social del desarrollo, que propone por primera vez una información de las funciones psíquicas superiores como la “internalización” mediada de la cultura y por tanto postula un sujeto social que no solo es activo sino interactivo” (p.67). Es así como las TIC pueden actuar como herramientas de mediación que facilitan la construcción del conocimiento en la carrera de medicina. Los estudiantes pueden interactuar con otros estudiantes, profesores y recursos en línea, lo que les permite participar en discusiones, colaborar en proyectos y acceder a información actualizada y relevante.

Con base a las premisas anteriormente expuestas en la teoría del aprendizaje constructivista respalda el desarrollo de las tecnologías de la información porque se enfoca en la obtención del aprendizaje por iniciativa del participante motivándolo a la autonomía para propiciar el desarrollo de destrezas. La teoría



constructivista trata de propiciar la capacidad de autonomía en el estudiante que sea un actor activo y consciente del propio desarrollo del conocimiento, actividad que se puede perfeccionar con la guía del docente. Sánchez Cortés et al. (2015)

Además de la teoría del constructivismo, la teoría de la Información y el conocimiento de (Davenport & Prusak, 1999) también fueron primordiales. Esta teoría plantea que la información reporta lo que acontece en el mundo a través de acciones y eventos, se observa que hay una gran diversidad entre datos, información y conocimiento. Los primeros son simples registros de acontecimientos, mientras que la información se remite a lo que interesa a alguien en particular y se vincula con sus inquietudes como observador de un hecho. De allí, se afirma que la información está constituida por datos, aun cuando no todo dato es información y no toda información tiene el mismo significado para todas las personas.

Por consiguiente, el conocimiento se expresa en la capacidad de acción eficaz; esto es que saber es saber hacer, y saber cómo. Echeverría (2003).

Desde esta perspectiva, la Teoría de la Información y el Conocimiento y el uso de las Tecnologías de la Información y Comunicación (TIC) como herramientas de aprendizaje, están articuladas desde la forma como estas últimas facilitan la transmisión, el procesamiento y la construcción del conocimiento a través de la administración de la información. En esta investigación, la utilización de las TIC, como herramientas de aprendizaje, representa un hecho significativo, ya que, de acuerdo con el correcto uso y manejo de la información, permite a los estudiantes de medicina acceder a recursos actualizados, investigaciones científicas, casos clínicos, videos educativos y herramientas interactivas, lo que les brinda la oportunidad de ampliar su conocimiento y mantenerse al día con los avances en el campo médico.

Las Tecnologías de información y comunicación representan un recurso de mucha importancia para el desarrollo de diversas actividades bien sea administrativas, gerenciales o educativas, en este sentido Cobo (2009), indica que las TIC son:

Dispositivos tecnológicos (hardware y software) que permiten editar, producir, almacenar, intercambiar y transmitir datos entre diferentes sistemas de información que cuentan con protocolos comunes. Estas aplicaciones, que integran medios de informática, telecomunicaciones y redes, posibilitan tanto la comunicación y colaboración interpersonal (persona a persona) como la multidireccional (uno a muchos o muchos a muchos). Estas herramientas desempeñan un papel sustantivo en la generación, intercambio, difusión, gestión y acceso al conocimiento. (p.313).

Además, es preciso destacar que, las TIC tienen un impacto significativo en la sociedad al facilitar la comunicación, el acceso a la información y el desarrollo de habilidades digitales. Así también, coincidimos con lo expuesto por Sánchez-Trujillo et al. (2024) el empleo herramientas digitales son potencialmente positivos para el fortalecimiento de la gestión del aprendizaje. Aunque no son el centro del proceso educativo, son un elemento mediador esencial que puede contribuir al desarrollo humano de los estudiantes y al logro de metas de formación establecidas en el currículo. A propósito, expresa, Davis (2020) "las TIC, sirven para potenciar el aprendizaje, fortalecer la interacción, las capacidades humanas y ampliar la sociedad de conocimiento al integrar lo local y global. De ahí que los temas de importancia global promueven la reflexión crítica". (p.16). Igualmente, Burgos Aguilar (2007) "afirma que el uso de nuevas herramientas tecnológicas extiende la aplicación de tecnologías tradicionales como el uso de videos, pizarra o libros de texto" (p.211), lo que crea amplias oportunidades para que los estudiantes puedan realizar simulaciones de problemas reales y prácticos.

Del mismo modo, según el objetivo y el contexto, las TIC pueden utilizarse en entornos educativos, ya sea en aplicación (pedagógica, curricular, entre otras), y las herramientas a la mano, como lo son las App. Tal como lo señalan, Kortabitarte et al. (2018) "Las App permiten acceder a ellas cuando y donde se quiera, facilitando así la contextualización del aprendizaje y la utilización del entorno en todo momento del proceso educativo" (p.67). Es importante tener en cuenta también, el tipo de docente involucrado en el uso de las TIC, a nivel pedagógico.

Metodología

La investigación se realizó bajo un enfoque cuantitativo de tipo descriptivo, con un diseño no experimental de campo. La población estuvo conformada por 42 residentes estudiantes de Postgrado. La muestra de tipo censal fue descriptiva, porque se tomaron en cuenta las características de la población escogida que, de acuerdo con Hernández Sampieri et al. (2008) ha sido definida como: "...los estudios descriptivos buscan especificar las propiedades importantes de personas, grupos, comunidades o cualquier otro fenómeno que sea sometido a análisis".

Técnicas e instrumentos de recolección de datos

La técnica utilizada en esta investigación fue la encuesta, definida por (Hernández Sampieri et al., 2008) como: "aquella que pretende obtener información que suministra un grupo o muestra de sujetos acerca de sí mismos o en relación con un tema en particular" (p.72). Se realizó a través de un cuestionario auto administrado, es decir, un conjunto de preguntas presentadas de forma escrita para que cada entrevistado respondiera sin intervención del encuestador. Este cuestionario constó de catorce (14) preguntas cerradas, de tipo dicotómicas establecidas previamente, con dos opciones de respuesta SI y NO; relacionadas con los objetivos de la investigación, el cual fue validado por tres expertos y para su confiabilidad se usó el Coeficiente de Kuder Richardson obteniendo como resultado 0,73.

Técnicas y análisis de la información

La información se analizó a través de la estadística descriptiva y la interpretación personal por parte de la investigadora; lo cual se fundamenta en contrastar las opiniones de los residentes, que conforman la población de esta investigación; la cual se realizó haciendo una vinculación con las bases teóricas y pedagógicas que sustentan el estudio, aplicando un análisis descriptivo, estadístico y deductivo.

El análisis descriptivo permitió la descripción objetiva, sistemática y cuantitativa del contenido general de la situación y de los teorizantes, de los cuales se obtuvo la interpretación que beneficia a la investigación sobre, el uso de TIC como herramienta de aprendizaje de los estudiantes de Postgrado de Obstetricia y Ginecología de la CHET. El análisis estadístico se efectuó con cada una de las preguntas realizadas en los instrumentos, acompañada con un breve comentario del resultado que arrojó y que el teorizante recomienda en el fortalecimiento de esos aspectos. Asimismo, se generaron gráficos de barra por cada pregunta con su respectivo análisis y porcentajes obtenidos. La deducción se aplicó luego de cuantificar los resultados obtenidos del instrumento y se presentaron como conclusión, luego de ser analizadas y graficadas todas las preguntas.

Resultados y discusión

El análisis de los datos recabados se realizó a través de la estadística descriptiva e inferencial de los resultados cuantitativos, mediante la organización y tabulación de los valores en frecuencias absolutas (fa) y su relación porcentual (%) ítem por ítem. En el análisis de los datos, se llevó a cabo una interpretación detallada de las respuestas proporcionadas por los médicos cursantes de post grado de ginecología y obstetricia de la Ciudad Hospitalaria Enrique Tejera. Los promedios se clasificaron en frecuencias y porcentajes de cada indicador con su respectivo análisis, dando lugar al cuerpo de conclusiones y recomendaciones. A continuación, se presenta el resumen de los resultados obtenidos.

Variable: Uso de TIC.

Dimensión: Integración tecnológica.

Indicador: Información académica.

Ítem 1: Utiliza dispositivos electrónicos (computadoras, tabletas, Smartphone) para acceder a material de estudio relacionado con la ginecología y obstetricia.

Tabla 1.
Distribución de frecuencias y porcentaje ítem 1

Ítems	SI		NO	
	F	%	F	%
1	39	93	3	7

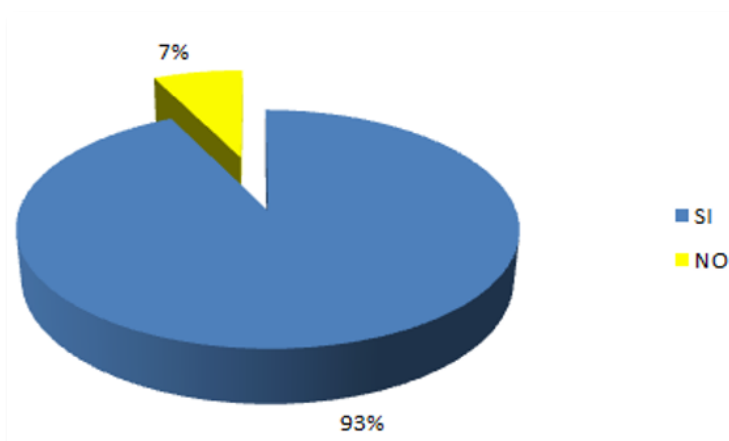


Gráfico 1. Distribución de porcentaje ítem 1

Interpretación: El 93% de los consultados expresó que utiliza dispositivos electrónicos (computadoras, tabletas, Smartphone) para acceder a material de estudio relacionado con la ginecología y obstetricia, mientras que el 7% indicó que no. Esta evidente mayoría que hace uso de las TIC se alinea con la perspectiva de Davis (2020), quien afirma que las TIC potencian el aprendizaje al facilitar el acceso a la información y al conocimiento, permitiendo una mayor interacción y fortaleciendo las capacidades humanas en un contexto educativo (p.16).

Variable: Uso de TIC

Dimensión: Integración tecnológica

Indicador: Información académica

Ítem 2: Utiliza redes sociales para seguir cuentas o grupos especializados en ginecología y obstetricia que compartan información académica.

Tabla 2.
Distribución de frecuencias y porcentaje ítem 2

Ítems	SI		NO	
	F	%	F	%
2	41	98	1	2

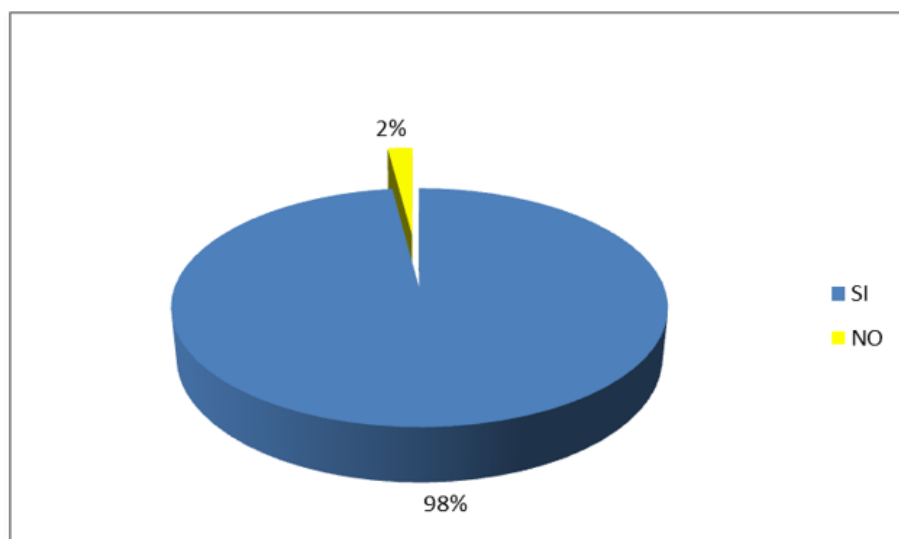


Gráfico 2. Distribución de porcentaje ítem 2

Interpretación: El 98% de los estudiantes expresa que utiliza redes sociales para seguir cuentas o grupos especializados en ginecología y obstetricia que compartan información académica, mientras que un 2% manifiesta no hacerlo. La posibilidad de gestión de la información tiene un poder relevante en las redes sociales. Esto significa poner al alcance de muchas personas contenidos para fortalecer el conocimiento y el aprendizaje. (Pérez Alcalá et al., 2015). De acuerdo con esto, la utilización masiva de redes sociales por parte de los estudiantes de postgrado en ginecología y obstetricia destaca la relevancia de las TIC, particularmente en su capacidad para facilitar el acceso y la participación en comunidades académicas especializadas.

Variable: Uso de TIC

Dimensión: Integración tecnológica

Indicador: Información académica

Ítem 3: Consideras que el uso de tecnologías de información y comunicación facilita el acceso a material de estudio actualizado en ginecología y obstetricia.

Tabla 3.

Distribución de frecuencias y porcentaje ítem 3

Ítems	SI		NO	
	F	%	F	%
3	42	100	0	0

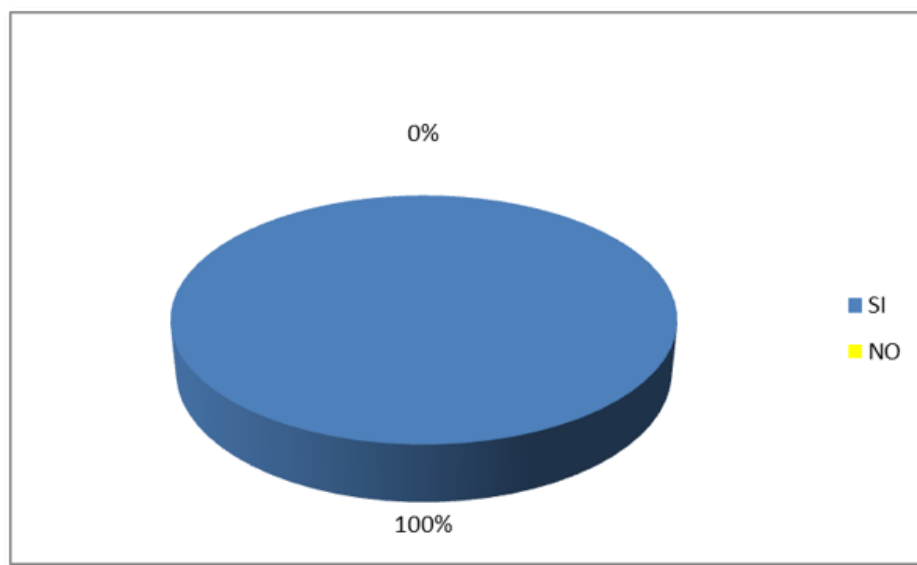


Gráfico 3. Distribución de porcentaje ítem 3

Interpretación: El 100% de los consultados, considera que el uso de tecnologías de información y comunicación facilita el acceso a material de estudio actualizado en ginecología y obstetricia. Las TIC permiten la búsqueda de información en menor tiempo, por tanto, el éxito del aprendizaje se eleva, la variedad de los recursos multimedia con los que cuenta se aprovecha, en mayor grado, las funciones de los órganos sensoriales impulsan la independencia cognoscitiva del estudiante. (Vidal del Toro et al., 2015).

Variable: Uso de TIC

Dimensión: Integración tecnológica

Indicador: Aprendizaje

Ítem 4: Participa en cursos en línea o Webinar relacionados con temas de ginecología y obstetricia.

Tabla 4.

Distribución de frecuencias y porcentaje ítem 4

Ítems	SI			NO	
	F	%	F	%	
4	38	90	4	10	

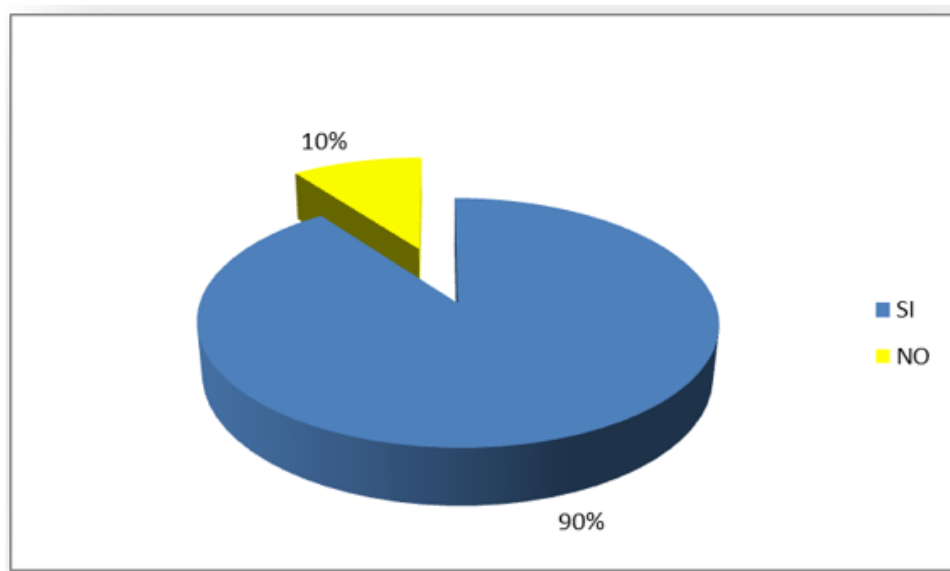


Gráfico 4. Distribución de porcentaje ítem 4

Interpretación: El 90% de los encuestados que participa en cursos en línea o Webinar relacionados con ginecología y obstetricia destaca la relevancia de las Tecnologías de la Información y Comunicación (TIC) como herramientas clave para la educación continua en el campo médico. Este alto nivel de participación refleja un compromiso significativo con el aprendizaje constante y la actualización profesional, lo cual es esencial en un campo que evoluciona tan rápidamente como la ginecología y obstetricia. Este resultado está alineado con lo expresado por (Linares Pons et al., 2014), quienes señalan que “la introducción de las TIC en los procesos docentes de los centros de ciencias médicas, a través de los programas de estudio y nuevas concepciones en el uso de los medios de enseñanza, exige un reacomodo en las estrategias educativas, permitiendo la participación más activa del alumno en su propio aprendizaje” (p.8).

Variable: Uso de TIC

Dimensión: Integración tecnológica

Indicador: Aprendizaje

Ítem 5: Interactúas con tus profesores o colegas a través de plataformas virtuales para discutir temas de estudio.

Tabla 5.

Distribución de frecuencias y porcentaje ítem 5

Ítems	SI		NO	
	F	%	F	%
5	38	90	4	10

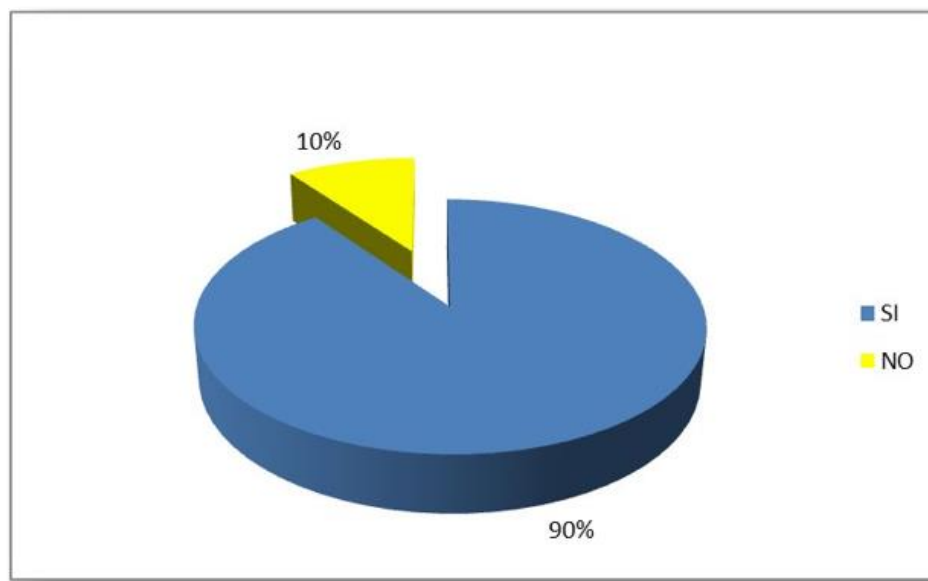


Gráfico 5. Distribución de porcentaje ítem 5

Interpretación: El 90% de los estudiantes que interactúan con sus profesores o colegas a través de plataformas virtuales para discutir temas de estudio destaca la relevancia de las TIC en la promoción de la colaboración y el intercambio de conocimiento en la educación médica. Este alto nivel de interacción refleja cómo las TIC no solo facilitan el acceso a recursos educativos, sino que también fomentan la comunicación y el aprendizaje. Mientras que el 10% de los estudiantes que no participa en estas interacciones virtuales podría estar enfrentando limitaciones tecnológicas, falta de confianza en el uso de estas herramientas. Garcés Prettel & Ruiz Cantillo (2016) expresan, “El docente participativo promueve la interacción educativa (foro, debates, retroalimentación) y el pragmatista potencia el aprendizaje por problemas por medio del pensamiento crítico usando simuladores y otros programas educativos. (p.9).

Variable: Ventajas

Dimensión: Acceso y uso de recursos tecnológicos

Indicador: Información

Ítem 6: Cree que las aplicaciones móviles y plataformas en línea permiten una mayor flexibilidad en tu proceso de aprendizaje en ginecología y obstetricia.

Tabla 6.

Distribución de frecuencias y porcentaje ítem 6

Ítems	SI		NO	
	F	%	F	%
6	38	90	4	10

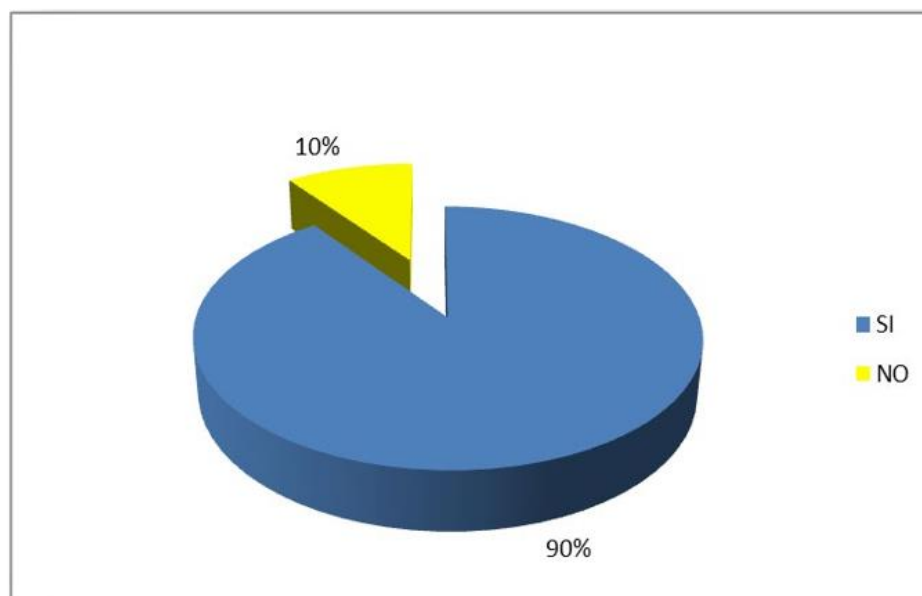


Gráfico 6. Distribución de porcentaje ítem 7

Interpretación: El 90% de los consultados cree que las aplicaciones móviles y plataformas en línea permiten una mayor flexibilidad en su proceso de aprendizaje en ginecología y obstetricia. El 10% piensa que no es así. En concordancia con lo aportado por (Kortabitarte et al., 2018) “Las App permiten acceder a ellas cuando y donde se quiera, facilitando así la contextualización del aprendizaje y la utilización del entorno en todo momento del proceso educativo” (p.67). Lo que recalca la importancia de integrar tecnologías móviles y plataformas virtuales en el ámbito educativo para responder a las necesidades y expectativas de los futuros profesionales en áreas especializadas como la ginecología y obstetricia.

Variable: Ventajas

Dimensión: Acceso y uso de recursos tecnológicos

Indicador: Información

Ítem: 7 Piensa que las búsquedas en línea te permiten acceder a información relevante y variada sobre temas específicos en ginecología y obstetricia.

Tabla 7.

Distribución de frecuencias y porcentaje ítem 7

Ítems	SI		NO	
	F	%	F	%
7	34	80	8	20

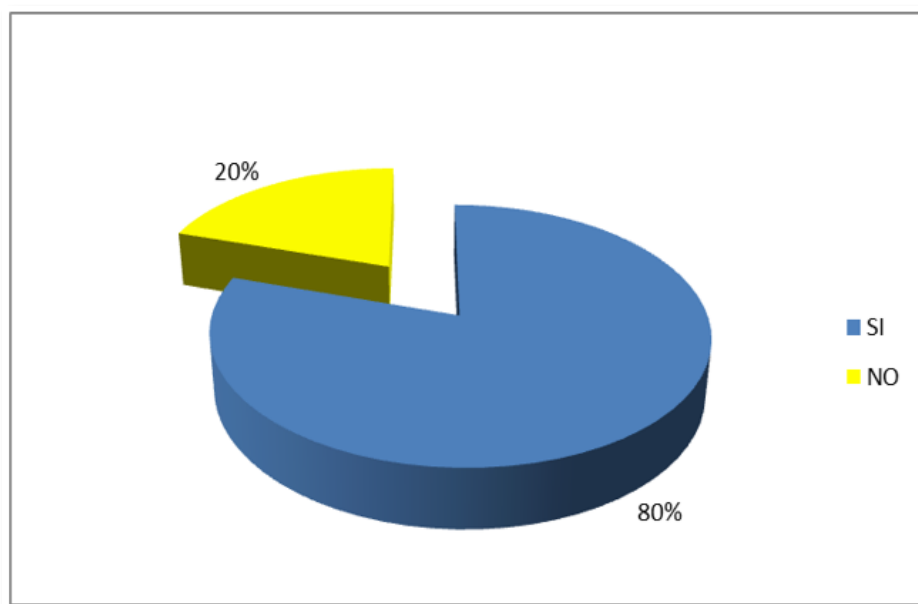


Gráfico 7. Distribución de porcentaje ítem

Interpretación: El 80% de los encuestados, piensa que las búsquedas en línea te permiten acceder a información relevante y variada sobre temas específicos en ginecología y obstetricia, mientras que el 20% opina que no. Este resultado refuerza la idea de que el acceso a recursos digitales facilita la adquisición de conocimientos actualizados, diversificados y accesibles en cualquier momento. Las tecnologías de la información y la comunicación no solo amplían el acceso a la información, sino que también permiten una formación más autónoma, flexible y personalizada, adaptada a las necesidades y ritmos de los estudiantes. (Cabero-Almenara, 2020, p. 3).

Conclusiones

Como punto de partida el análisis de los resultados es posible llegar a conclusiones acerca de las implicaciones y significados que estos hallazgos aportan al contexto de la investigación cuyo objetivo general fue; analizar el uso de TIC como herramienta de aprendizaje de los estudiantes de Postgrado de Obstetricia y Ginecología de la ciudad hospitalaria Enrique Tejera (CHET). El mismo, no solo permitió solo identificar las preferencias y modelos más notables, sino también comprender cómo estos se interrelacionan con los objetivos planteados. A continuación, se presentan las principales conclusiones que surgen de este análisis.

En cuanto a la descripción del uso de TIC, los estudiantes de postgrado en obstetricia y ginecología de la CHET, las emplean activamente en su proceso de aprendizaje, especialmente para acceder a materiales de estudio, participar en cursos y Webinar, y conectarse con comunidades académicas especializadas a través de redes sociales y plataformas virtuales. Es evidente la forma como las TIC han facilitado la interacción entre estudiantes y profesores, suscitando el intercambio de conocimiento y fomentando el aprendizaje colaborativo. No obstante, existen retos asociados con el acceso y las barreras tecnológicas, lo que resalta la necesidad del establecimiento de mejoras en las habilidades digitales de los estudiantes. Con relación a las ventajas del uso de TIC, entre las más resaltantes está el acceso rápido a información actualizada, la variedad de recursos multimedia que enriquecen el aprendizaje, articulando con la promoción permanente de la flexibilidad en el proceso educativo, asumiendo las necesidades y ritmo de estudio individual de los estudiantes. Otro aspecto importante es el avance de la autonomía en el aprendizaje a través de exámenes en línea y autoevaluaciones, lo que facilita la retroalimentación

constante y mejora del rendimiento académico, sin dejar de lado la simulación clínica que representa una ventaja significativa, complementando la formación práctica sin poner en riesgo a los pacientes.

Finalmente, en relación con las características apropiadas de las TIC para utilizarlas como herramienta de aprendizaje de los estudiantes, estas incluyen dispositivos electrónicos como computadoras, tabletas y Smartphone, que permiten el acceso a plataformas digitales y aplicaciones móviles. Estas plataformas ofrecen flexibilidad, disponibilidad continua y la posibilidad de realizar simulaciones clínicas. Además, las redes sociales y foros en línea facilitan el aprendizaje colaborativo y la participación en comunidades especializadas, promoviendo el intercambio de conocimientos y la reflexión crítica. Las TIC también permiten la integración de múltiples recursos sensoriales, mejorando la retención de información y el aprendizaje profundo.

Limitaciones metodológicas

Para los docentes:

- Capacitación en TIC: La actualización permanente de los docentes, es fundamental, haciendo énfasis en herramientas como simuladores clínicos, plataformas virtuales y aplicaciones educativas para mejorar el aprendizaje práctico.
- Promover el aprendizaje colaborativo: Partiendo de actividades que impulsen el trabajo en equipo y la interacción entre estudiantes a través de plataformas virtuales, como los foros y redes sociales especializadas para el intercambio de conocimientos y la reflexión.

Para los estudiantes:

- Desarrollar habilidades digitales: Enfocándose en mejorar sus competencias digitales para aprovechar al máximo las TIC en su formación.
- Participación activa en comunidades virtuales: Involucrándose activamente en grupos especializados en obstetricia y ginecología a través de redes sociales, foros y plataformas virtuales.

Para la CHET:

- Mejorar la infraestructura tecnológica: El hospital debería garantizar que todos los estudiantes tengan acceso adecuado a las TIC, minimizando las barreras tecnológicas, por tanto, es esencial que se inviertan recursos en la mejora de la infraestructura tecnológica, tanto en equipamiento como en conectividad.
- Implementar programas de formación tecnológica: Desarrollando programas específicos de formación en habilidades digitales, tanto para docentes como para estudiantes, para asegurar un uso óptimo de las TIC en el proceso de enseñanza y aprendizaje.

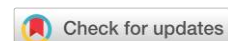
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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.11>

Cómo citar:

Orlovskiy, B., Dobrianska, N., Ivanchenko, E., Fedchyshyn, S., & Komisarchuk, R. (2025). Educational models for developing customs, brokerage and law enforcement expertise in EU–Ukraine cross-border cooperation. *Revista Eduweb*, 19(2), 157-166. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.11>

Educational models for developing customs, brokerage and law enforcement expertise in EU–Ukraine cross-border cooperation

Modelos educativos para el desarrollo de la experiencia en aduanas, corretaje y aplicación de la ley en la cooperación transfronteriza entre la UE y Ucrania

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Recibido: 03/03/25
 Aceptado: 22/06/25

Abstract

The article aims to examine the critical role of education and professional training in strengthening customs control between Ukraine and the European Union. Its objective is to evaluate how educational initiatives support the harmonization of customs legislation, the adoption of modern systems such as the New Computerized Transit System (NCTS), and the broader modernization of customs procedures. The research employs a multi-method approach, including analysis of regulatory and legal documents,



comparative studies of EU-aligned educational models, and case studies of training programs for customs officials, brokers, and law enforcement agents. The study identifies significant progress in aligning Ukrainian customs training programs with European standards. It highlights the integration of digital learning platforms, competency-based frameworks, and interdisciplinary curricula as essential components in enhancing the professional competencies of customs personnel. The analysis shows that these initiatives have positively influenced institutional capacity, improved regulatory compliance, and facilitated more efficient trade operations. Key findings reveal that education and training are pivotal for legal harmonization and effective governance within the EU integration process. The article concludes with recommendations for advancing customs education through international collaboration, the use of technology-enhanced learning, and continual reform to support Ukraine's strategic economic alignment with the European Union.

Keywords: training of specialists, teaching, customs control, common transit, integration, customs legislation, harmonization.

Resumen

El artículo tiene como objetivo examinar el papel fundamental de la educación y la formación profesional en el fortalecimiento del control aduanero entre Ucrania y la Unión Europea. Su propósito es evaluar cómo las iniciativas educativas apoyan la armonización de la legislación aduanera, la adopción de sistemas modernos como el Nuevo Sistema Informatizado de Tránsito (NCTS) y la modernización general de los procedimientos aduaneros. La investigación emplea un enfoque metodológico múltiple, que incluye el análisis de documentos normativos y jurídicos, estudios comparativos de modelos educativos alineados con la UE y estudios de caso sobre programas de formación para funcionarios de aduanas, agentes de aduanas y fuerzas del orden. El estudio identifica avances significativos en la alineación de los programas de formación aduanera de Ucrania con los estándares europeos. Destaca la integración de plataformas de aprendizaje digital, marcos basados en competencias y planes de estudio interdisciplinarios como componentes esenciales para mejorar las competencias profesionales del personal aduanero. El análisis demuestra que estas iniciativas han influido positivamente en la capacidad institucional, mejorado el cumplimiento normativo y facilitado operaciones comerciales más eficientes. Los hallazgos clave revelan que la educación y la formación son fundamentales para la armonización legal y una gobernanza eficaz en el proceso de integración europea. El artículo concluye con recomendaciones para avanzar en la educación aduanera mediante la colaboración internacional, el uso de tecnologías educativas y la reforma continua que respalde la alineación económica estratégica de Ucrania con la Unión Europea.

Palabras clave: formación de especialistas, docencia, control aduanero, tránsito común, integración, legislación aduanera, armonización.

Introduction

The deepening economic and political integration between Ukraine and the European Union (EU) has significantly heightened the demand for qualified professionals in customs control, brokerage, and law enforcement. As Ukraine advances toward closer alignment with the EU through the Association Agreement and the Deep and Comprehensive Free Trade Area (DCFTA), customs procedures must increasingly reflect European regulatory norms and digital standards. This transition requires a workforce with both technical expertise and legal literacy in EU customs procedures, trade facilitation frameworks, and cross-border security mechanisms.

However, recent studies reveal a critical educational gap. According to a 2023 report by the State Customs Service of Ukraine, only 28% of customs personnel have received structured training aligned with EU regulations. Furthermore, less than 35% of training institutions offer practical instruction using core EU digital platforms such as the New Computerized Transit System (NCTS), Import Control System (ICS), and Export Control System (ECS) (PwC Ukraine, 2023). These digital platforms are foundational for automating



customs declarations and improving traceability in trade flows. The absence of such training has led to operational delays, regulatory inconsistencies, and increased risks of non-compliance.

For example, an audit conducted in 2023 by the European Commission identified persistent issues in the application of the Common Transit Convention by Ukrainian customs offices, citing insufficient staff training and poor familiarity with EU risk management protocols (European Commission, 2023). The report also highlighted that only a minority of Ukrainian customs training programs incorporated real-time simulations or cross-border case studies, tools widely used in EU member states to develop practical problem-solving competencies.

This evidence underscores the urgent need for a modernized educational framework that integrates EU-aligned content, digital tools, and competency-based learning. Without such reform, Ukraine risks falling behind in fulfilling its international obligations, delaying full access to European transit regimes and undermining trust with EU trade partners.

Research Tasks:

- Examine the current educational framework for customs training in Ukraine and the EU.
- Assess the impact of training initiatives on professionals' ability to implement the New Computerized Transit System (NCTS) and reduce administrative burdens.
- Evaluate the role of modern learning technologies, such as simulations and digital case studies, in improving customs education.
- Identify gaps in educational programs and propose solutions to enhance professional competency.

Conducting this research is essential for refining the education and training of customs professionals, ensuring they are equipped to facilitate Ukraine's integration into the European customs system. By enhancing educational strategies, Ukraine can strengthen its regulatory capacity, improve compliance with EU trade policies, and foster economic cooperation with European partners.

This article is structured as follows: Section 2 presents the theoretical framework and literature review, examining existing research on customs education. Section 3 outlines the methodology used in analyzing Ukraine's customs training system. Section 4 discusses the results, including the current state of education, digital integration, and joint initiatives with the EU. Section 5 concludes with key findings, challenges, and practical recommendations for reforming customs education in Ukraine.

Theoretical Framework and Literature Review

The Association Agreement and the Deep and Comprehensive Free Trade Area (DCFTA) between Ukraine and the European Union (EU) have triggered substantial reforms in customs procedures, emphasizing the strategic role of education in preparing a skilled workforce capable of navigating regulatory, technological, and organizational challenges. As Ukraine harmonizes its customs legislation with the EU Customs Code, customs officers, brokers, and law enforcement professionals require advanced competencies in both national and supranational legal frameworks, digital systems, and international compliance mechanisms such as the Revised Kyoto Convention and WTO standards.

EU-Aligned Competency Development

Ališauskas (2023) underlines the necessity of integrating Ukraine's customs education into the broader EU customs ecosystem. His research identifies key priorities, including harmonization of training curricula with European standards, the adoption of advanced customs data processing systems in academic programs, and the institutionalization of risk analysis training. He further advocates for structured partnerships between Ukrainian educational institutions and EU customs authorities as a mechanism for alignment with European best practices.

In a similar vein, Kuznyak & Svichkar (2018) analyze the EU's pedagogical approaches, noting their emphasis on harmonized curricula, simplified learning trajectories, and the implementation of competency-based education. These frameworks are foundational for shaping professionals who can function effectively within the EU's regulatory and operational environment.

Digital Transformation of Customs Training

The role of digital tools in modern customs education is extensively covered in the literature. Berezhniuk et al. (2015) explore the implementation of integrated customs systems such as the Import Control System (ICS), Export Control System (ECS), and the New Computerized Transit System (NCTS) within training curricula in EU countries. Their findings emphasize how automation supports procedural transparency, accelerates customs clearance, and enhances the detection of smuggling and other trade-related risks.

Building on this, Kril (2021) evaluates the integration of NCTS into Ukrainian customs education. The study demonstrates that targeted training on electronic transit procedures improves logistical efficiency and transparency while also revealing technical and human resource limitations that hinder full-scale implementation.

Structural Gaps in Ukrainian Customs Education

A number of scholars critically assess the shortcomings of Ukraine's current customs training system. Vdovina & Slatvinska (2020) point to outdated curricula, insufficient integration of digital tools, and the absence of standardized professional qualifications. They propose a series of reforms including competency-based assessments, modernization of training content, and strategic collaboration with EU partners.

Dorofeeva & Korneva (2023) further argue that disparities in instructional methodologies, coupled with a lack of technological infrastructure, impede Ukraine's capacity to meet EU educational benchmarks. They recommend the development of degree programs specifically tailored to EU customs standards, the use of digital simulations, and the adoption of case-based teaching to foster applied competencies.

Dyachuk (2024) adds a regional dimension by analyzing professional training at Ukraine's western customs borders. The study identifies the lack of real-time training systems and practical modules as a key barrier to aligning field-level customs practices with EU procedures.

Emphasis on Experiential and Risk-Based Learning

Chirkova & Bortnikova (2022) highlight the effectiveness of simulation-based learning for training on the Common Transit Procedure (NCTS), showing that experiential education enhances customs clearance efficiency and decision-making accuracy.

Similarly, Kharkaviy (2013) explores the educational value of post-clearance audit simulations. His findings illustrate how audit-based learning models strengthen procedural knowledge and improve regulatory compliance among customs professionals.

Legislative and Institutional Dimensions

Tuchak & Mohylska (2018) examine the broader legal framework of customs education reform, focusing on the legislative alignment needed to support curriculum modernization. Their study recommends adapting Ukrainian customs training to reflect EU directives and international legal standards, particularly in the context of integrated border management.

Synthesis of Key Trends

The reviewed literature reveals several dominant trends shaping customs education reform:

Digitalization and Automation: The integration of platforms such as ICS, ECS, and NCTS into educational programs is a prevailing priority. These tools promote transparency, reduce manual processing, and improve operational readiness (Berezhniuk et al., 2015; Kril, 2021).

Curriculum Harmonization: Standardizing educational content with EU requirements is essential. Tuchak & Mohylska (2018) emphasize competency-based education as a solution for bridging regulatory gaps.

Cross-Border Collaboration: Joint training with EU customs institutions, international certification, and participation in EU-led workshops are seen as effective mechanisms for capacity building (Dyachuk, 2024).

Practical Training and Simulations: Experiential learning, including trade simulations and case-based training, significantly improves real-world customs enforcement capabilities (Chirkova & Bortnikova, 2022).

Trade Facilitation and Risk Management: Several studies link advanced training with improved trade efficiency, risk assessment, and smuggling prevention (Kharkaviy, 2013; Goncharenko, 2023).

Methodology

This research adopts a qualitative and exploratory approach to examine the role of education and professional training in strengthening customs control between Ukraine and the European Union.

The study was conducted in several interrelated stages:

Document Analysis:

An in-depth legal and regulatory review was carried out to assess the foundational framework of customs education in Ukraine in light of EU integration. Key documents analyzed include:

The Customs Code of Ukraine (Law No. 4495-VI, 2012; State Customs Service of Ukraine, 2024),

Amendments introduced by Law No. 3926-IX (2024),

EU Regulation No. 952/2013 (Union Customs Code), (European Parliament and of the Council, 2013a)

EU Regulation No. 1186/2009 (on exemptions from customs duties), (European Parliament and of the Council, 2009).

EU Regulation No. 608/2013 (on enforcement of intellectual property rights at the border), (European Parliament and of the Council, 2013b).

The Convention on a Common Transit Procedure (European Economic Community, 1987), and

Order No. 86 (2021) of the Ministry of Finance of Ukraine on the implementation of the New Computerized Transit System (NCTS).

This legal review established the normative basis for evaluating educational harmonization with EU customs standards.

Expert Interviews:

Twelve semi-structured interviews were conducted with customs officials, academic personnel from customs training institutions, and policy advisors in Ukraine, Poland, and Hungary. The interviews explored:

The structure and content of customs training programs,

Their alignment with EU regulations and digital systems,

Perceived gaps in competencies and institutional readiness.

The interviews were transcribed and analyzed using thematic coding, enabling the identification of recurring patterns and critical insights across national contexts.

Case Study Analysis:

Four cross-border training initiatives involving Ukraine and EU member states were selected for detailed examination. The selection criteria included:

Presence of digital components (e.g., NCTS, ECS, ICS),

Institutional collaboration (e.g., joint training centers or EU-funded projects),

Availability of documented outcome evaluations or impact reports.

These case studies provided empirical evidence of best practices and obstacles in the practical implementation of harmonized customs education.

Analytical Framework:

A set of evaluation criteria was used to assess the findings from interviews and case studies, including:

Alignment with EU customs procedures and competencies,

Integration of digital tools and simulation platforms,

Application of competency-based training models,

Contributions to institutional capacity-building and regulatory convergence.

Additionally, a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) was performed to assess the strategic positioning of Ukraine's customs education system in the context of European integration.

This multi-method research design, combining legal-regulatory analysis, qualitative interviews, and case-based evaluation, enables a nuanced understanding of Ukraine's customs education system. The triangulation of data sources ensures both normative accuracy and practical relevance, forming a robust basis for conclusions and policy recommendations.

Results and Discussion

As Ukraine moves closer toward European integration, the importance of modern education and training in the customs sector becomes increasingly evident. Customs officers, brokers, and law enforcement personnel play a central role in trade regulation, risk management, and border control. Ensuring that they are well-trained is essential not only for compliance with EU standards but also for streamlining customs procedures, reducing corruption, and fostering economic cooperation.

Customs brokers, in particular, need a combination of legal knowledge and technological skills. Their education must include both Ukrainian and European customs legislation, especially Regulation (EU) No. 952/2013, which lays the foundation for customs procedures across the Union. A sound understanding of tariff classification, rules of origin, and customs valuation is key. But theory alone isn't enough—brokers must also be proficient in using electronic customs systems, including risk management tools and the EU's Single Window environment.

There's growing emphasis on trade compliance, especially through mechanisms like the Authorized Economic Operator (AEO) program. Brokers trained in these areas can help businesses meet regulatory requirements efficiently. At the same time, ethics and anti-corruption are crucial components of training, given the historical challenges customs services have faced in these areas.

Education for customs officials must also reflect the broader legal environment. Instruments such as the Convention on the Simplification of Formalities in Trade in Goods and the Convention on a Common Transit Procedure influence the design of customs processes and, by extension, the structure of customs education. These conventions emphasize streamlined documentation and unified procedures—principles that should be mirrored in the way customs students are taught. Furthermore, Regulation (EU) No. 608/2013, concerning the enforcement of intellectual property rights, requires officers to be trained in identifying counterfeit goods and managing related enforcement actions.

Ukraine is making visible efforts to align with these expectations. Reforms are underway to update training programs, modernize customs education, and increase the use of digital tools. The Ukrainian Center for Economic and Political Studies notes that changes are being made to better integrate electronic data systems and align national customs education with European standards. However, many programs still lag behind due to outdated materials, a lack of modern equipment, and limited international partnerships.

VisitUkraine reports that joint border control with the EU is on the horizon, which brings with it a need for even more specialized training. Officials must be familiar with surveillance technologies, real-time risk analysis, and international cooperation protocols. Such developments underscore the growing complexity of customs work and the corresponding need for hands-on, applied learning.

The benefits of joint EU–Ukraine training programs are significant. These initiatives help reduce procedural duplication, accelerate customs clearance, and cut costs for businesses. By learning together, Ukrainian and EU professionals can build a shared understanding of procedures and expectations, ultimately improving coordination and efficiency.

Law enforcement and border control are also part of the customs equation. Officers in these roles must be trained in international legal standards and crime prevention frameworks. Equipping them with skills in operating technologies like X-ray scanners, biometric identification, and AI-driven analytics is essential for keeping up with modern threats. At the same time, enforcement must be balanced with respect for human rights and adherence to EU norms.

Digital transformation plays a major role in all of this. The European Commission's 2024 Ukraine Report stresses the importance of integrating systems like the Import Control System (ICS) and Export Control System (ECS) into customs training. These tools allow real-time data exchange and support interactive learning. Ukraine's State Customs Service has already outlined a strategic plan for digitalization, which includes developing online learning platforms, AI-driven simulations, and certification systems based on EU benchmarks.

Nevertheless, challenges remain. Many training institutions still lack access to digital technologies, and traditional curricula often do not provide sufficient practical experience. Regulatory differences between Ukraine and the EU also require constant updates to training programs.

At the same time, there are opportunities. Closer collaboration with EU customs academies could bring valuable expertise and shared resources. Investments in technologies like VR and AI could transform how customs officers are trained. And bilingual programs in Ukrainian and English could help integrate Ukrainian professionals into broader European customs networks.

Ultimately, education remains a cornerstone of customs reform. A forward-looking training system—modern, digital, and internationally aligned—will help Ukraine develop the skilled workforce it needs to operate within the EU customs framework. With the right investments and partnerships, Ukraine can build a customs service that not only enforces the law effectively but also facilitates trade, supports businesses, and enhances its standing in the European economic space.

Conclusions

In conclusion, comprehensive education and training of specialists in brokerage activities, customs services, and law enforcement are fundamental to ensuring the smooth integration of Ukraine into the European customs system. By aligning its educational frameworks with EU best practices, Ukraine can enhance its customs control mechanisms, facilitate trade more efficiently, and strengthen law enforcement capabilities within the context of European integration.

Alignment with Educational Objectives

Regarding the first objective, an analysis of Ukraine's customs education framework revealed that while Ukraine is gradually harmonizing its training programs with EU standards, gaps remain in digital competencies, practical training, and curriculum standardization. The EU Customs Code (UCC) and the Association Agreement between Ukraine and the EU serve as primary reference points for curriculum development. However, post-audit procedures, risk management training, and competency-based learning need further improvement to align fully with European standards.

Regarding the second objective, assessing the impact of training programs on NCTS implementation, findings indicate that while digitalization in customs training has improved, many professionals still require specialized instruction in automated customs systems. The New Computerized Transit System (NCTS), introduced in Ukraine in 2022, has simplified customs operations but requires ongoing personnel training to maximize its effectiveness. Future training programs should emphasize hands-on learning with NCTS interfaces, case-based problem-solving, and real-time customs simulations.

Regarding the role of information technologies in customs education, findings demonstrate that ICS and ECS training modules enhance transparency in customs procedures. Implementing Import Control System (ICS) and Export Control System (ECS) training ensures that customs professionals can conduct real-time tracking of imports and exports, improving risk assessment and fraud prevention. In Ukraine, integrating these technology-focused learning strategies into customs training will accelerate process automation, reduce human errors, and minimize corruption risks.

Challenges and Recommendations for Improving Customs Education

Despite the progress in modernizing customs education and training programs, the study identified several challenges:

Limited access to digital learning tools. Many Ukrainian educational institutions lack the necessary customs simulation software and automated training platforms to provide real-world customs procedure experience.

Low level of automation in training. Traditional teaching methods do not adequately prepare customs professionals for the highly digitalized EU customs environment.

Gaps in professional competencies. Customs officers require more advanced training in risk-based inspections, post-clearance audit procedures, and fraud detection.

Insufficient international cooperation. Exchange programs and joint educational initiatives between Ukrainian and EU institutions remain limited, restricting knowledge transfer.

To address these challenges, the following strategic recommendations should be implemented:

Modernize educational infrastructure by equipping training centers with AI-driven customs simulators, e-learning platforms, and real-time customs processing tools.

Enhance digital literacy among customs professionals by expanding virtual training in ICS, ECS, and NCTS. Strengthen collaboration with EU customs academies to standardize training curricula and introduce joint certification programs for customs officers.

Increase funding for specialized training in cross-border trade regulations, compliance risk assessment, and fraud prevention techniques.

Develop bilingual education programs (Ukrainian and English) to align training content with international customs standards and facilitate knowledge exchange.

The Role of Education in Ukraine's Customs Integration

Education and training play a pivotal role in facilitating Ukraine's customs modernization efforts. By reforming customs education, integrating digital training solutions, and fostering international partnerships, Ukraine can:

- Improve the efficiency of customs clearance procedures through better-trained specialists.
- Enhance risk-based customs inspections with data-driven decision-making skills.
- Strengthen compliance with EU regulations by equipping professionals with theoretical and practical expertise.
- Foster innovation in customs enforcement through AI-powered training and real-world simulations.

Future Research Directions

For further scientific research, it is advisable to study the experience of EU countries in customs training models, particularly the implementation of blended learning, AI-driven fraud detection training, and competency-based customs education frameworks. Additionally, analyzing the impact of digital learning innovations on customs personnel efficiency will provide valuable insights into how education can accelerate Ukraine's integration into the European customs space.

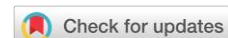
By prioritizing educational modernization, Ukraine will develop a skilled, adaptable, and internationally competitive customs workforce, ensuring that its professionals are well-prepared to navigate the complexities of global trade, regulatory compliance, and cross-border cooperation within the EU framework.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.12>

Cómo citar:

Berezovska, L., Saraieva, I., Britskan, T., Ushnevych, S., & Tytun, O. (2025). The use of educational technologies for ensuring continuity of preschool and primary education. *Revista Eduweb*, 19(2), 167-183. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.12>

The use of educational technologies for ensuring continuity of preschool and primary education

El uso de las tecnologías educativas para garantizar la continuidad de la educación preescolar y primaria

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Recibido: 09/02/25

Aceptado: 30/05/25

Abstract

The study investigated the effectiveness of educational technologies in ensuring the continuity between preschool and primary education, focusing on academic performance, emotional adaptation, and resilience. A mixed-methods approach was applied, involving questionnaires, standardized testing, and experimental implementation of digital platforms across five institutions (two kindergartens and three schools). The sample included 100 children, 60 parents, and 50 teachers. Key tools included ClassDojo, Kahoot, Google Classroom, and Minecraft Education. The results showed that 87% of children in the experimental group achieved a high level of adaptation (vs. 65% in the control group), anxiety decreased by 25%, and academic performance increased by 18%. Adaptive learning tools were especially effective for students with initially low school readiness.



(+20%). Statistical tests confirmed the significance of these changes ($t = 4.21$, $p = 0.002$; ANOVA $F = 5.72$, $p = 0.001$). Teachers and parents positively assessed the impact of digital tools, though challenges such as limited access in rural areas and insufficient teacher training were reported. The study concludes that educational technologies improve school readiness and motivation but require equitable infrastructure and targeted support. Future research should explore long-term outcomes and hybrid models that integrate traditional and digital pedagogy for inclusive early education.

Keywords: adaptation, educational technologies, gamification, interactive platforms, primary education.

Resumen

La importancia de la investigación sobre el uso de las tecnologías educativas para garantizar la continuidad de la educación preescolar y primaria viene determinada por la creciente necesidad de crear condiciones eficaces para una transición sin problemas de los niños de la educación preescolar a la primaria. La falta de programas de adaptación y soluciones tecnológicas conduce a una disminución del nivel de motivación para el aprendizaje de los niños. Las tecnologías modernas, como las plataformas interactivas, la gamificación y el aprendizaje adaptativo, pueden mejorar significativamente la calidad de esta transición. El objetivo del estudio es evaluar el impacto de las tecnologías educativas en el nivel de rendimiento de los niños en el período de transición entre la educación preescolar y la primaria. La investigación empleó los siguientes métodos: cuestionarios, pruebas y aplicación experimental de plataformas interactivas en instituciones educativas. Los resultados del estudio mostraron que el 87% de los niños demostró un alto nivel de adaptación después de la implementación de tecnologías educativas, en comparación con el 65% en el grupo control (GC). El rendimiento aumentó en un 18% y el nivel de ansiedad disminuyó en un 25%. Las perspectivas de investigación incluyen un análisis del impacto del uso a largo plazo de estas tecnologías en el rendimiento académico de los niños y la adaptación social.

Palabras clave: adaptación, educación primaria, gamificación, plataformas interactivas, tecnologías educativas.

Introduction

Modern educational technologies present both opportunities and challenges in ensuring the quality of the educational process. The transition from preschool to primary education is a crucial stage in a child's development, involving the acquisition of basic academic and social skills as well as adaptive mechanisms. However, traditional approaches often result in decreased motivation, heightened anxiety, and difficulties in adaptation. Studies indicate that up to 30% of children experience stress during this transition, with an increased risk of learning difficulties (Abakirova & Karasartova, 2024). Digital solutions, such as interactive platforms, adaptive learning, and gamification, have the potential to facilitate this process by fostering a supportive and engaging learning environment (Alzahrani, 2023). Despite these advantages, challenges remain, including unequal access to technology, insufficient teacher training, and difficulties in integrating digital and traditional pedagogical methods (Elshafey et al., 2024). Addressing these concerns requires a systematic approach to the implementation of educational technologies in early education.

This study provides a broader analysis of the impact of digital tools on preschool-to-primary transition without a direct application to a specific institution. Previous research has explored technology use in primary education (Eyyubov & Sakhavat, 2020), but this study expands upon existing findings by assessing its role in adaptation and long-term learning motivation.

The results aim to offer practical recommendations for the effective integration of digital technologies into the early education system.

The aim of the study is to assess the impact of educational technologies on the level of adaptation of children in the transitional period between preschool and primary education, as well as to develop recommendations for the integration of digital solutions into the educational process.



Empirical objectives:

1. Determine the impact of interactive platforms on the children's anxiety level during the transition to school;
2. Analyse the impact of gamification elements on children's learning motivation during the transition period;
3. Study the effectiveness of adaptive educational programmes in ensuring an individual approach to children;
4. Assess the attitude of teachers and parents to the implementation of modern educational technologies.

The results of the study will contribute to the improvement of educational practices and the development of innovative solutions to ensure a smooth transition of children between the stages of preschool and primary education. The importance of such studies is not only in solving practical problems, but also in shaping prospects for further improvement of the educational system.

Structure of the Article

The article begins with an introduction, where the relevance of the study is justified, and its objective is defined – to assess the impact of educational technologies on children's adaptation during the transition from preschool to primary school. The literature review analyzes previous studies in the field of digital educational technologies, their effectiveness, and potential implementation challenges. The methodology section presents the approaches to data collection, including the use of surveys, testing, and the experimental implementation of interactive platforms in educational institutions. The results and discussion section provides an analysis of the collected data, demonstrating improvements in children's adaptation and a reduction in anxiety levels after the use of educational technologies. It also examines the influence of various factors, such as the level of teachers' technical preparedness and the accessibility of digital resources. In the conclusion, the significance of the obtained results is summarized, perspectives for future research are outlined, and recommendations are provided for enhancing the integration of digital technologies into the primary education system.

Each section of the article addresses a key component of the research: the introduction defines the scope and rationale; the literature review contextualizes the study within previous research; the methodology outlines the empirical strategy; the results and discussion interpret the data in light of the study objectives; and the conclusion synthesizes findings and proposes practical and theoretical implications.

Literature Review

Current research on the impact of digital technologies on the educational process in primary schools has demonstrated a variety of approaches and perspectives regarding their effectiveness.

Kliziene et al. (2021) examined the influence of the virtual platform EDUKA on the academic performance of primary school students and found that the platform improved outcomes through personalized learning trajectories. However, Yan (2021) indicated that despite their potential to enhance education, modern digital technologies often encountered technical and organizational barriers that limited their effectiveness. This perspective was echoed by Yizengaw & Nigussie (2023), who highlighted restricted access to educational technologies in many schools as a major constraint on their impact.

Shvardak (2023) analyzed the use of interactive technologies in primary education and reported an increase in student engagement. In contrast, Alzahrani (2023) questioned the universality of such strategies, pointing out that their outcomes depended on students' prior preparation and socio-cultural background.

Quiles-Rodríguez et al. (2024) investigated the effect of coloured lighting on students' affective responses and concluded that while certain lighting types had a positive impact, their effectiveness relied on

integration with other educational tools. Similarly, Price et al. (2024) emphasized the role of classroom lighting, though they stated that its influence was contingent on the technical condition of school facilities.

Shuima et al. (2024) explored teachers' perceptions of technology in the educational process in the Maldives. They reported that although most teachers positively evaluated the implementation of technology, they faced difficulties due to the lack of adequate training and institutional support.

Atil Lemoualdi (2021) investigated the importance of electronic media in early childhood education, emphasizing their potential for developing basic competencies. However, the study highlighted that insufficient content control could result in negative consequences. While this approach was considered valuable, the issue of integrating media into the educational process remained insufficiently examined in the context of primary education, which reduced the practical relevance of the findings for older age groups.

Elshafey et al. (2024) analyzed the integration of educational technologies into learning processes and stressed the importance of adapting platforms to students' specific needs. Although the study underscored the value of an individual approach, the research mainly addressed universal solutions and did not account for socio-cultural and technical disparities across regions, thereby limiting the generalizability of its application.

Larionova & Filippenko (2023) confirmed the positive impact of information and communication technologies on student success, but noted that the level of technical support in schools was a key factor influencing effectiveness. However, the importance of teachers' methodological training was not addressed, despite its direct influence on successful technology integration.

Ray (2019) examined the impact of early childhood education on academic performance in core school subjects. The study emphasized that early childhood education formed a foundation for later learning, but the effect diminished without structured support. Only general recommendations were provided, with no analysis of mechanisms for sustaining early advantages in primary school.

Oluwayimika & Eberechukwu (2022) investigated the role of modern technologies in higher education and highlighted their potential for increasing student engagement. However, the adaptation of these methods to primary education was only briefly mentioned, leaving open questions regarding age-specific implementation challenges.

Zakieva & Shirieva (2019) explored the use of innovative lighting in classrooms, stressing its impact on attention and performance. Although their research focused on vocational education, the authors suggested possible application in primary schools. However, no specific recommendations were offered regarding integration with digital learning tools in early grades.

The transition from preschool to primary education presents significant challenges for children, educators, and parents alike. Studies indicate that up to 25–30% of children experience heightened anxiety during this transition, which can negatively impact their academic performance and social adaptation (Ray, 2019). Additionally, research suggests that children who struggle with adaptation in early primary school are at a higher risk of future academic difficulties and lower motivation levels (Alzahrani, 2023). The lack of structured adaptation programs and unequal access to digital learning tools further complicates this process (Yizengaw & Nigussie, 2023).

Current research on digital technologies in primary education demonstrates varied perspectives on their effectiveness in addressing these challenges. Kliziene et al. (2021) studied the use of the virtual platform EDUKA and found that personalized learning trajectories improved student outcomes, which is relevant to easing the preschool-to-primary transition. In contrast, Yan (2021) highlights technical and organizational barriers that prevent the full realization of technology's potential in education. This argument is further supported by Elshafey et al. (2024), who emphasize the necessity of adapting digital tools to students'



needs but note that most research focuses on universal solutions without considering regional socio-cultural and technical disparities.

This study expands upon the above findings by exploring the impact of multiple digital technologies across diverse educational environments, including both urban and rural contexts. Unlike studies conducted in individual institutions, the current analysis reflects a system-level approach, enabling broader generalization of outcomes and identification of contextual barriers such as infrastructure, teacher readiness, and family engagement.

Regarding engagement and motivation, Shvardak (2023) explores the role of interactive technologies in increasing student engagement, which is particularly relevant for maintaining learning motivation in early grades. However, Alzahrani (2023) questions the universal effectiveness of digital practices, emphasizing that their success depends on students' initial preparation and socio-cultural background.

Environmental factors also play a role in the transition process. Quiles-Rodríguez et al. (2024) analyzed how colored lighting affects students' affective processes, concluding that optimized lighting can enhance learning conditions. However, Price et al. (2024) argue that the effectiveness of lighting depends on classroom infrastructure and technical conditions, which are often overlooked in discussions on digital education. Similarly, Zakieva & Shirieva (2019) examined innovative lighting in vocational education, suggesting that their findings could be adapted for primary schools, though they do not provide specific recommendations for younger learners.

Teacher perceptions and training are also critical in the digital transition. Shuima et al. (2024) found that while most teachers support technology integration, they often lack proper training and institutional support. Larionova & Filippenko (2023) confirm the positive impact of ICT on student success, but they also highlight technical limitations in schools, which can hinder its effectiveness. Notably, they do not address the importance of teachers' methodological preparedness, which remains a key factor in successful technology adoption.

Early childhood education research provides further insight into transition challenges. Ray (2019) argues that early education serves as a foundation for later academic success, but without structured support, its benefits can diminish over time. However, his study offers only general recommendations without analyzing the specific mechanisms necessary for sustaining early learning advantages in primary school.

The role of media and digital content in education has also been explored. Atil Lemoualdi (2021) emphasizes the potential of electronic media in developing foundational skills, though he warns of negative consequences due to insufficient content regulation. His study, however, focuses primarily on early childhood education, making its findings less applicable to older primary school students.

In higher education, Oluwayimika & Eberechukwu (2022) examined modern technologies' role in increasing engagement, briefly mentioning their adaptation for primary schools. However, their study does not explore age-specific implementation challenges, leaving gaps in understanding how digital solutions can be tailored for younger learners.

Unlike previous research that focuses on specific institutions or case studies, this study provides a broader analysis of the impact of digital technologies on preschool-to-primary transition without direct application to a particular school or educational system. While many studies address individual aspects of digital education, such as engagement (Shvardak, 2023), technological barriers (Yan, 2021), or environmental factors (Quiles-Rodríguez et al., 2024), this research seeks to integrate these perspectives into a comprehensive framework. By examining multiple factors—including student adaptation, anxiety levels, and long-term academic impact—this study expands upon existing findings to provide practical recommendations for a more effective transition strategy.

Methodology

The study employed a mixed-methods quasi-experimental design with a pre- and post-intervention structure to assess the effectiveness of educational technologies in ensuring continuity between preschool and primary education. The research was conducted in three stages, combining theoretical and empirical approaches while maintaining methodological rigor through statistical significance testing.

The first stage involved a theoretical analysis of modern educational technologies, including interactive platforms, adaptive learning, and gamification elements. This analysis covered peer-reviewed scientific publications, reports from international educational organizations, and case studies of technology implementation in educational institutions, providing a foundation for selecting the most relevant technological tools for further empirical evaluation.

The second stage focused on data collection and systematization, which included a structured survey of 50 teachers and 60 parents regarding their perceptions of digital education, an assessment of school readiness in 100 children measuring their cognitive, social, and emotional adaptation through standardized tests, and an analysis of the impact of educational technology implementation in five institutions, including two urban kindergartens and three rural primary schools, to account for diverse learning environments. The institutions were selected to reflect variability in digital infrastructure, enabling comparison between technology-rich and resource-limited settings.

The third stage consisted of a quantitative and qualitative analysis of the collected data, utilizing questionnaires, standardized testing, and comparative analysis of children's performance before and after technology implementation. Participants were divided into experimental and control groups to isolate the impact of digital interventions. To ensure statistical validity, paired t-tests and ANOVA were applied to determine the significance of observed changes in adaptation, learning outcomes, and anxiety levels, ensuring the reliability and robustness of the findings. Ethical approval was obtained from the relevant institutional research committee, and informed consent was secured from all participants or their legal guardians.

Methods

To ensure methodological rigor, the study employed a mixed-methods quasi-experimental design with pre- and post-intervention measurements. The following methods were applied:

Questionnaire survey: teachers and parents provided insights into the advantages and challenges of educational technologies.

Testing of children: school readiness, anxiety levels, and adaptation were measured through standardized tests administered under teacher supervision.

Comparative analysis: pre- and post-implementation data on children's performance, motivation, and adaptation were analyzed, with participants divided into an experimental group (EG) using digital platforms and a control group (CG) following traditional methods.

Statistical analysis: to ensure validity, paired t-tests and ANOVA (Analysis of Variance) were applied to assess the statistical significance of changes in adaptation and performance indicators. Significance thresholds were set at $p < 0.05$.

Informed consent was obtained from parents and legal guardians of all participating children. Ethical approval for the study was granted by the institutional research board, and participation was voluntary.

The inclusion of statistical significance tests (p -values < 0.05) enhances the reliability of conclusions



regarding the impact of educational technologies.

Sample

The study collected data from three main groups:

Teachers (n = 50): ten teachers from each of the five educational institutions (two kindergartens and three primary schools), located in both urban and rural areas with varying levels of digital infrastructure. The institutions were selected to represent diverse educational environments, allowing for broader generalization of the findings. Participants were selected based on willingness to participate, experience in early childhood education (minimum three years), and qualification category (primarily II, I, and highest categories).

Parents (n = 60): parents of children in the study were surveyed to explore their perceptions of educational technologies and their role in supporting children during the transition. The selection criteria included willingness to participate and interest in digital education. The sample size was smaller than the number of children, as some families had multiple children in preschool or primary school.

Children (n = 100): the sample included 50 preschool children and 50 primary school students, selected based on parental consent, children's curiosity, and willingness to participate. This distribution allowed for a comparative analysis of adaptation and performance between different age groups and educational stages. The study design accounted for variations in school environments, ensuring that both resource-rich and resource-limited institutions were represented.

Instruments

The following tools were used for the study:

- Google Forms: for conducting a survey of teachers and parents.
- SPSS: for processing and analysing questionnaire data and test results.

Table 1 presents the interactive platforms used in the study to ensure continuity of preschool and primary education.

Table 1.
Interactive learning platforms

Technology	Purpose of use	Frequency of use	Target group
ClassDojo	Maintaining discipline, engaging in learning	3 times a week	Children, parents, teachers
Kahoot	Conducting interactive quizzes	1 time a week	Children
Google Classroom	Managing educational materials	Daily	Children, teachers
Minecraft Education	Developing creative thinking	1 time every two weeks	Children

Source: developed by the authors

Additionally, a set of standardized tests was developed for measuring children's school readiness, including components related to cognitive functioning, emotional regulation, and basic academic competencies.

Testing was conducted in-person under teacher supervision to ensure accuracy and minimize external influences. All testing procedures were aligned with early childhood assessment standards and conducted in a quiet, distraction-free environment.

The incorporation of these methods and tools ensured objectivity and reliability in the study's findings. The

use of triangulation through surveys, testing, and comparative data strengthened the internal validity of the results. This methodological integration enabled the formulation of evidence-based recommendations for integrating digital technologies into the preschool and primary education system, with applicability across varied institutional contexts.

Results and Discussion

An important aspect of ensuring continuity between preschool and primary education is supporting children's emotional stability during the transition. This period is often accompanied by high anxiety due to the change in the learning environment, new social contacts and learning requirements.

Before the introduction of interactive platforms, 60% of children showed a medium anxiety level, 15% - high, and only 25% felt confident. After the introduction, the proportion of children with a high level of adaptation increased from 25% to 47% (+22%), and the anxiety level decreased to 10% (-5%). No such changes occurred in the CG: 62% remained at a medium level of anxiety, and the high level decreased by only 2%. These changes were measured using standardized emotional adaptation tests administered before and after the intervention. A paired t-test confirmed that the reduction in anxiety in the experimental group was statistically significant ($t = 4.21$, $p = 0.002$), indicating a strong effect of the digital tools on emotional stability.

The platforms contributed to an individual approach, thanks to which children felt more confident and interacted better with their environment. Performance improvements were more pronounced in urban institutions, likely due to better digital infrastructure and more consistent teacher training. Rural schools experienced difficulties in accessing equipment. Table 2 presents the interactive educational technology programmes used in the study. It includes the purpose, frequency of use, effectiveness, and teacher feedback demonstrating the practical value of these platforms.

Table 2 presents the interactive educational technology programmes used in the study. It includes the purpose, frequency of use, effectiveness, and teacher feedback demonstrating the practical value of these platforms.

Table 2.
Educational Technology Programme

Technology	Purpose of use	Frequency of use	Target group	Results	Teacher assessment	Teachers' comments/suggestions
ClassDojo	Maintaining discipline, engaging in learning	3 times a week	Children, parents, teachers	Increased child engagement by 25%	4.5	Parents find the platform easy to use
Kahoot	Conducting interactive quizzes	1 time a week	Children	Increased learning motivation by 18%	4	Students ask to use the platform more often
Google Classroom	Managing educational materials	Daily	Children, teachers	Simplified access to materials	4,8	Recommended for older children
Minecraft Education	Developing creative thinking through simulations	1 time every two weeks	Children	Developed student creativity	4.7	Most effective for children 6–7 years old

Source: developed by the authors

Educational technologies were used to support discipline, creativity, and motivation. Google Classroom provided daily access to materials (score 4.8), ClassDojo and Kahoot facilitated communication and quizzes, and Minecraft Education effectively developed creativity. The teachers suggested using the platforms more often and providing training for parents.

Table 3 demonstrates changes in children's adaptation levels before and after using interactive platforms, including a significant increase in the proportion of children with a high level of adaptation (by 22%) and a decrease in the proportion of children with a low level of adaptation (by 15%). These results were based on standardized adaptation assessments administered to all participants. A paired t-test confirmed that the increase in high adaptation levels in the experimental group was statistically significant ($t = 3.76$, $p = 0.006$), indicating that the intervention had a measurable and reliable effect.

Table 3.

Children's adaptation levels before and after using interactive platforms

Adaptation level	Before use (%)	After use (%)	Absolute number of children (before)	Absolute number of children (after)	Percentage change (%)	Explanation of changes
Low	25	10	25	10	-15	Decrease due to confidence gained through interactive platforms
Medium	60	43	60	43	-17	Decrease due to gradual transition to a high level
High	15	47	15	47	32	Growth due to positive environment and individual approach

Source: developed by the authors.

The integration of gamification increased children's learning motivation by 18%. This change was measured using standardized motivational scales before and after the implementation of game-based tools. A paired t-test confirmed the statistical significance of the increase ($t = 3.54$, $p = 0.009$), indicating that gamification had a notable effect on engagement. 85% of parents and 80% of teachers noted the positive impact of game elements, which reduced anxiety and increased self-confidence. These results were collected through structured questionnaires distributed via Google Forms, allowing participants to provide feedback on the observed behavioral and emotional changes. Interactive tasks, such as team competitions and instant feedback, contributed to children's adaptation, although teachers emphasized the need for additional technical support.

Figure 1 shows changes in children's learning motivation before and after the introduction of gamification elements.

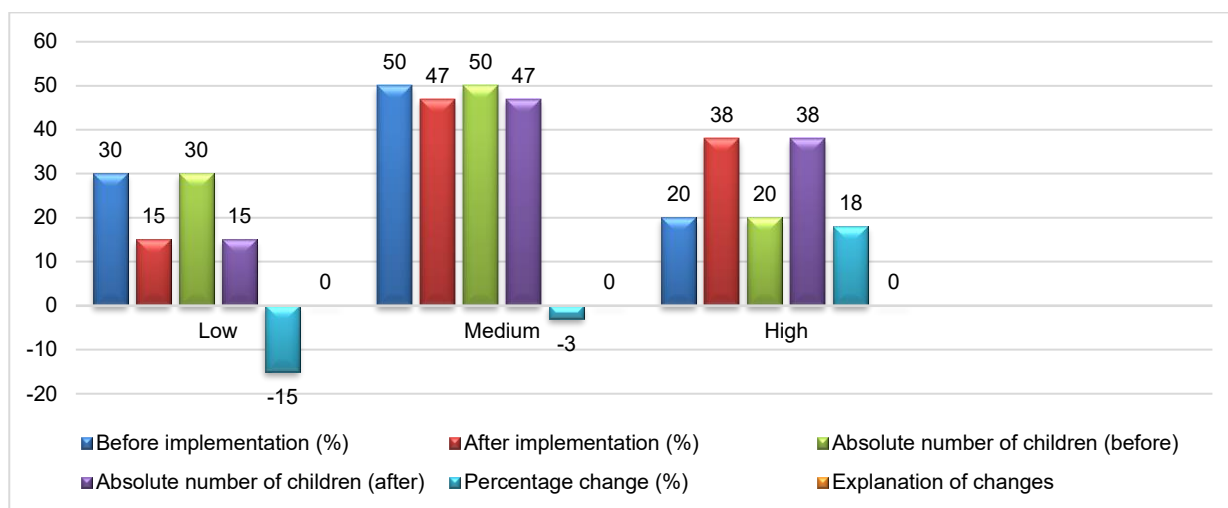


Figure 1. The level of children's learning motivation before and after the introduction of gamification elements

Source: developed by authors

Adaptive programmes increased the children's overall performance by 15%, and among children with low school readiness – by 20%. These results were based on standardized academic performance tests conducted before and after the intervention. Automatic task adjustment made it possible to avoid overload and maintain student interest. The greatest progress was observed in solving mathematical problems and logical problems. A paired t-test confirmed that the overall improvement in performance was statistically significant ($t = 3.89$, $p = 0.004$), particularly among students who initially demonstrated low readiness levels. ClassDojo and Google Classroom made it easier to monitor performance, allowing for adjustments to the educational process. In rural schools, difficulties arose with technical support, and teachers emphasized the need for additional training. Limited infrastructure and the absence of targeted professional development were identified as key constraints affecting the consistency of digital technology implementation.

Table 4 compares the performance of children in groups with traditional and adaptive approaches to learning.

Table 4.

Comparison of the children's performance in groups with traditional and adaptive approaches to learning

Performance rate	Traditional approach (%)	Adaptive approach (%)	Absolute number of children (traditional approach)	Absolute number of children (adaptive approach)	Percentage change (%)	Explanation of changes
Low	40	20	40	20	-20	Reduction due to individualization of tasks
Medium	45	50	45	50	5	Stable growth due to adaptation of the educational process
High	15	30	15	30	15	Significant growth due to maintenance of high results

Source: developed by the authors.

The assessment of the attitude of teachers and parents towards the use of digital technologies in the educational process demonstrated a significant level of support for the implementation of such tools. According to the survey results, 80% of teachers and 85% of parents noted the positive impact of educational technologies on the educational process. The main benefits they indicated were reduced stress in children, especially during the transition between stages of education, as well as increased learning motivation. These data were collected through structured online questionnaires using Google Forms and reflect qualitative assessments of perceived impact.

The parents noted that the use of interactive platforms and adaptive programmes creates a more comfortable learning environment that takes into account the individual needs of their children. For example, 70% of respondents from the parent category emphasized that access to feedback through digital platforms allows them to better understand their child's progress and more effectively support them during their studies. At the same time, 65% of teachers confirmed that technologies such as gamification and adaptive learning help to make lessons more interesting and easier to learn.

Despite this, some respondents, namely 35% of teachers, noted that the implementation of digital technologies requires additional training, as there is a lack of technical training for the full use of the platforms. This concern was more frequently expressed by educators in regions with limited technical infrastructure and fewer institutional support mechanisms. Uneven access to equipment in different regions was identified among other shortcomings, which creates obstacles to the large-scale implementation of innovative approaches.

It is interesting that a significant part of parents (about 45%) expressed a desire to receive more information about the use of educational platforms to help children to learn. These findings highlight the importance of involving parents in the digital learning process, suggesting the potential value of informational workshops or explanatory materials.

Figure 2 shows the results of the survey of teachers and parents.

The introduction of educational technologies into the educational process has had a positive impact on the children's readiness for school, as confirmed by the results of testing. Before the use of interactive platforms and adaptive programmes, only 70% of children demonstrated a sufficient level of readiness for school. This figure increased to 88% after the introduction of digital technologies, which indicates the effectiveness of innovative methods in preparing children for school. The data were obtained through standardized school readiness assessments administered before and after the intervention. A paired t-test confirmed that the increase in readiness was statistically significant ($t = 4.08$, $p = 0.003$).

Major improvements were recorded in cognitive skills, such as the ability to solve problems, the development of logical thinking and attention. For example, the results of tests for mathematical preparation showed an increase in average scores by 20%. This growth was particularly evident in task areas requiring abstract reasoning and sequential thinking. Children who previously demonstrated difficulties in completing logical tasks significantly improved their results thanks to adaptive programmes that allowed real-time adjustment of task complexity to meet individual performance levels.

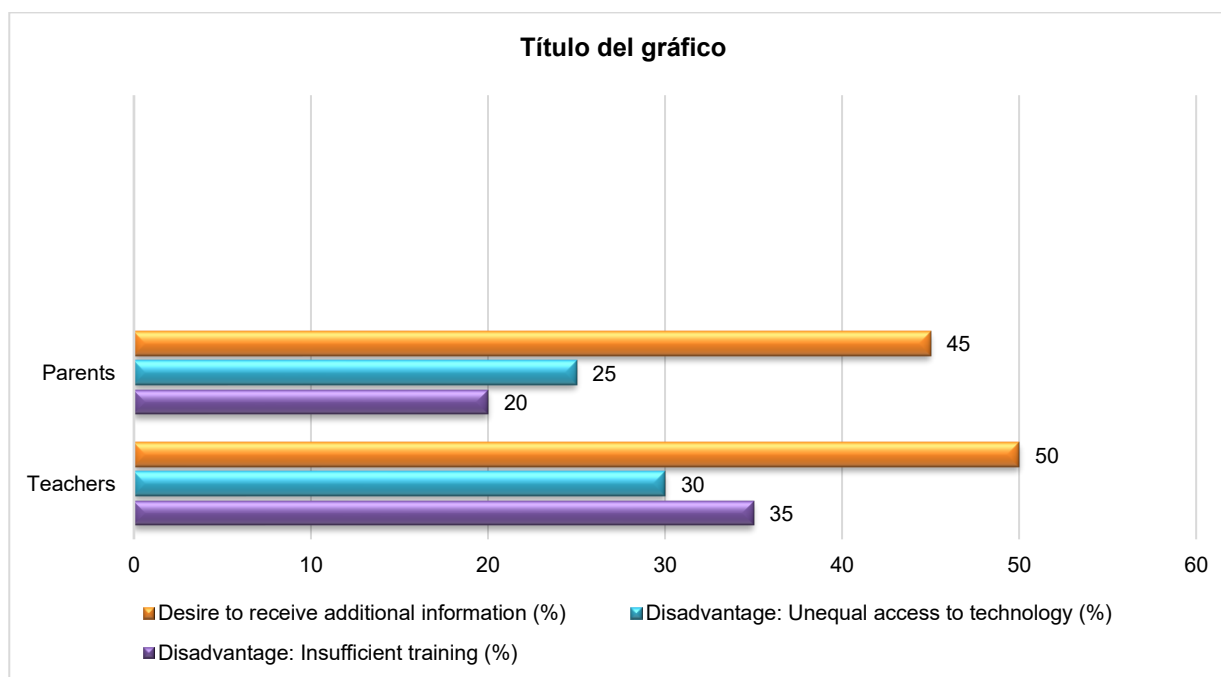


Figure 2. Results of a survey of teachers and parents on the advantages and disadvantages of digital educational technologies.

Source: developed by authors

Table 5 shows the indicators of children's readiness for school before and after the introduction of digital technologies.

Table 5.

Indicators of children's readiness for school before and after the introduction of digital technologies

Readiness Indicators	Before technology introduction	After technology introduction	Percentage change (%)	Absolute number of children (before)	Absolute number of children (after)	Explanation of changes
General Readiness (%)	70	88	18	70	88	Increased overall readiness through an individual approach
Cognitive Skills (%)	65	85	20	65	85	Development of cognitive skills through adaptive tasks
Social Adaptation (%)	68	82	14	68	82	Social adaptation improved through gamification
Logical Thinking (%)	60	80	20	60	80	Logical thinking increased through interactive tasks
Mathematical Preparation (%)	62	82	20	62	82	Mathematical preparation improved through personalized programs

Source: developed by the authors.

The use of educational technologies was found to be effective in preparing children for school, particularly in the development of cognitive and social skills. This approach demonstrated practical benefits for

improving the educational process, although it required adequate technical support and equitable access to digital resources across different regions.

To ensure the statistical validity of the observed improvements in adaptation and academic performance, paired t-tests and ANOVA were applied. The paired t-test for adaptation levels before and after the implementation of interactive platforms revealed a statistically significant improvement ($t = 4.21$, $p = 0.002$), indicating a measurable reduction in anxiety and enhanced emotional stability. The paired t-test for academic performance showed a significant increase in post-intervention results ($t = 3.89$, $p = 0.004$). A one-way ANOVA confirmed statistically significant differences in adaptation and performance across varied implementation contexts ($F = 5.72$, $p = 0.001$).

These findings provided empirical support for the effectiveness of digital education technologies in improving school readiness, reducing anxiety, and supporting academic achievement. However, differences in infrastructure, teacher preparedness, and access to equipment between urban and rural schools appeared to influence the consistency of outcomes. Further studies were recommended to apply multivariate statistical models to control for these external variables and to examine the long-term impact of digital learning tools.

The results of this study were consistent with previous research on the impact of educational technologies in early education and revealed certain discrepancies and contextual limitations. Studies by Abakirova & Karasartova (2024) demonstrated that the integration of digital tools significantly improved students' academic performance and engagement, particularly through personalized learning approaches. Elshafey et al. (2024) reported that adaptive learning platforms contributed to cognitive development; however, their analysis focused on universal applications and did not account for regional disparities. The results of the current study confirmed these findings, showing an 18% increase in learning motivation and a 15% improvement in overall school readiness. Unlike earlier research assuming equal access to educational technologies, the present data revealed implementation challenges in rural schools related to infrastructure and resource constraints.

A critical discrepancy was observed in comparison with the findings of Romanyuk et al. (2023), who emphasized the role of traditional pedagogical approaches in the development of foundational skills. Although digital technologies used in this study contributed to improved adaptation and reduced anxiety, they did not fully replace in-person interaction and conventional teaching, particularly in the domain of social development. These findings supported the position that a hybrid model combining digital and traditional pedagogies was more effective in early education settings.

Qu (2023) noted that teachers' attitudes toward technology directly affected their willingness to integrate digital tools into lessons. The present results aligned with this observation: teachers who had prior digital training were more confident and actively used interactive platforms, while those with limited exposure required additional support and showed greater resistance to integration.

Beyond the direct impact of technology, several contextual variables influenced the outcomes observed in this study. Disparities in infrastructure were identified as a significant determinant. Urban schools operated with more stable internet access, adequate devices, and consistent technical support, while rural institutions encountered outdated equipment and unreliable connectivity. These findings corresponded with the study by Recalde et al. (2020), who emphasized the need to improve school infrastructure to achieve equitable integration of educational technologies.

The level of teacher preparedness also affected the effectiveness of digital platform implementation. Educational institutions where teachers had received prior training in interactive tools and adaptive learning systems reported higher levels of student progress. In contrast, schools where teachers had limited or no exposure to such technologies experienced delays and inconsistencies. These results reflected the conclusions of Hayat & Iqbal (2024), who identified teacher training as a critical factor in the successful application of educational technologies. The data further showed that teachers in urban schools more

frequently received institutional support and participated in training initiatives, whereas teachers in rural areas often relied on self-instruction or operated without formal resources, which led to inconsistent adoption practices.

Technological inequality was also identified as a barrier to the adoption of digital learning, particularly in households that lacked access to personal computers, tablets, or stable internet connectivity. Parents in urban environments demonstrated greater familiarity with educational applications, which enabled them to support their children's learning, whereas families in rural areas often lacked the technical competence or necessary resources to assist effectively. This observation confirmed the conclusions of Yasmin & Rumi (2020), who argued that students' socio-economic background substantially affected their ability to engage with digital tools.

Despite the documented benefits of digital technologies, several barriers limited their effective and widespread implementation. One of the key obstacles was the insufficient level of teacher training and institutional support. According to the study, 35% of educators reported being unprepared to integrate digital platforms into the educational process. These findings aligned with the conclusions of Radul (2022), who emphasized teacher readiness as a determining factor for the success of digital learning strategies. Another challenge involved unequal access to resources in rural schools, where limited funding and infrastructure constrained the application of interactive technologies.

Additionally, approximately 45% of parents expressed a need for more information about educational technologies, indicating the necessity of targeted informational and training initiatives. This issue had received limited attention in previous research; however, the findings of the current study demonstrated that parental involvement played a significant role in the success of digital learning. Therefore, organizing digital literacy workshops for parents was proposed as a potential strategy to enhance their engagement and effectiveness in supporting children.

The limited duration of the intervention represented another constraint of the study. The impact of educational technologies was assessed over a short-term period, without the inclusion of longitudinal data. This limitation reflected the concerns raised by Yeşilyurt (2023), who noted that while immediate positive outcomes were observable, the long-term effects of digital platforms remained insufficiently explored. Further research was recommended to employ longitudinal designs that would allow the tracking of progress over extended periods and provide deeper insights into the sustainability of improvements in adaptation, motivation, and academic performance.

Finally, although the study concentrated on interactive platforms and adaptive learning tools, more advanced technologies such as 3D holographic learning environments and immersive simulations, as examined by Hoon & Shaharuddin (2019), were not included in the experimental design. This omission identified a potential direction for future research on the applicability and effectiveness of emerging technologies in early childhood education.

Recent Latin American studies have also contributed to the understanding of educational technology in early learning contexts. Borges et al. (2020) conducted a systematic review of open educational resource repositories and highlighted their growing relevance in improving pedagogical practices across Spanish-speaking countries. Their findings suggest that access to curated digital content supports individualized learning and fosters inclusive education, particularly in resource-limited settings. Similarly, Moya et al. (2020) analyzed the educational use of social network platforms and found that their strategic implementation enhances student engagement and teacher-student communication. While their study primarily focuses on Spanish and English contexts, the inclusion of Latin American contributions provides a broader perspective on the cultural adaptability of digital learning tools. These studies complement the present research by reinforcing the importance of digital accessibility and cultural contextualization in technology-based learning environments.

Implications for Policy and Practice

Based on the obtained findings, several practical recommendations were formulated for improving the use of educational technology in preschool and primary school settings. First, teacher training programmes required expansion to ensure that educators possessed the necessary digital competencies to integrate technology effectively into the learning process. Second, investment in digital infrastructure—especially in underserved rural regions—was identified as a critical priority for governments and educational institutions, aiming to reduce technological disparities and ensure equal access to learning tools.

Furthermore, the study underscored the importance of parental involvement. It was recommended that educational authorities introduce workshops and explanatory materials to assist families in navigating digital learning platforms. In addition, the adoption of a hybrid educational model, combining digital tools with conventional pedagogical practices, was proposed as a balanced and inclusive approach to improve learning outcomes.

By addressing these identified barriers and contextual limitations, the implementation of educational technologies could be optimized, thereby ensuring that children from different socio-economic and regional backgrounds received equal opportunities for successful adaptation during the transition to primary education.

Limitations

The study had several limitations. Unequal access to digital technologies, especially in rural schools, influenced the implementation outcomes due to limited infrastructure and outdated equipment. In some cases, insufficient teacher training restricted the effective use of platform features. The sample size (50 teachers and 60 parents) limits generalizability and should be expanded in future research.

The short duration of the intervention also restricted assessment of long-term effects. Additionally, the study relied on commercial platforms not tailored to local pedagogical or cultural contexts, which may have affected results. Finally, the quasi-experimental design limits causal conclusions, as external variables could have influenced the observed outcomes.

Recommendations

To enhance the effectiveness of educational technology implementation, it is necessary to improve access to digital infrastructure, especially in rural areas where outdated equipment and limited connectivity hinder progress. Teacher training programmes should be expanded and institutionalized, with a specific focus on the pedagogical use of interactive and adaptive learning tools. Ensuring equitable learning opportunities requires the development of localized versions of digital platforms that reflect regional languages, curricula, and socio-cultural contexts. Future studies should involve larger and more diverse samples to strengthen the validity of results and assess the long-term impact of digital technologies on academic performance and emotional adaptation.

Conclusions

The study confirmed the significant potential of digital educational technologies in facilitating continuity between preschool and primary education. The use of interactive platforms—ClassDojo, Kahoot, Google Classroom, and Minecraft Education—demonstrated a measurable reduction in children's anxiety levels and contributed to improved adaptation during the transition period. Gamification elements were found to stimulate learning motivation, particularly enhancing engagement in the early stages of formal education. Adaptive curricula proved effective in improving academic outcomes, especially among children with initially low levels of school readiness.

A survey of teachers and parents confirmed a high level of support for the implementation of technologies that help to reduce stress in children and enhance learning motivation. Testing of children also showed a significant increase in their readiness for school, with the greatest progress observed in cognitive skills and social adaptation.

The academic novelty of the study is the integrated approach to analysing the effectiveness of digital technologies in ensuring the continuity of education, which includes the implementation of interactive platforms, gamification elements, and adaptive programmes. A feature of the research is the study of the impact of these technologies in different conditions, including urban and rural educational institutions.

The practical value of the study is the possibility of implementing the results obtained to optimize the educational process. They can be used to develop teacher training programmes, create recommendations for integrating digital technologies into the educational process, as well as to improve methods for adapting children to the new educational environment.

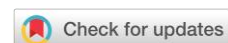
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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.13>

Cómo citar:

Halukha, L. (2025). Modern approaches to resolving intergenerational conflict in education: innovations and practical recommendations. *Revista Eduweb*, 19(2), 184-198. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.13>

Modern approaches to resolving intergenerational conflict in education: innovations and practical recommendations

Enfoques modernos para resolver conflictos intergeneracionales en la educación: innovaciones y recomendaciones prácticas

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Recibido: 02/05/25

Aceptado: 20/06/25

Abstract

Intergenerational conflict is a pressing challenge requiring a nuanced understanding of modern scientific discourse. The purpose is to identify modern approaches to this intergenerational conflict and to formulate recommendations for resolving misunderstandings within the higher education system. The type of research is quantitative, which involves a semi-structured survey. A purposive sample was used to include participants. The study participants comprise teachers (n = 35) and administrative representatives (n = 15). A total of 50 individuals participated. The survey was conducted in person in December 2024. The results show that most respondents are somewhat dissatisfied with the current level of cooperation between different generations of teachers. The primary reason for the emergence of generational conflict is the differing communication styles. The survey results show that all participants in the educational process recognize the negative impact of generational conflict on the organization of the educational process, especially. Administrative staff of educational institutions generally understand the importance of overcoming the consequences of generational conflict. A possible direction is to engage actively in intergenerational educational and research projects. The conclusions emphasize that this will contribute to establishing more effective mutual understanding among the teaching staff.

Keywords: generational differences, education, intergenerational conflict, teaching strategies, pedagogical innovations.

Resumen

El conflicto de generaciones es un reto urgente que requiere una comprensión detallada en el discurso científico moderno. El propósito es identificar los enfoques modernos de este conflicto de generaciones y formular recomendaciones para resolver los malentendidos en el sistema de enseñanza superior. El tipo de investigación es cuantitativo, lo que implicó una encuesta semiestructurada. Se utilizó una muestra intencional para incluir a los participantes. Los participantes en el estudio son profesores (n=35) y representantes de la administración (n=15). Participaron un total de 50 personas. La encuesta se realizó en diciembre de 2024 de forma presencial. Los resultados muestran que la mayoría de los encuestados están bastante insatisfechos con el nivel actual de cooperación entre las distintas generaciones de profesores. La principal razón de la aparición de conflictos generacionales es el estilo de comunicación. Los resultados de la encuesta muestran que todos los participantes en el proceso educativo reconocen especialmente el impacto negativo del conflicto generacional en la organización del proceso educativo. En general, el personal administrativo de los centros educativos comprende la importancia de superar las consecuencias del conflicto generacional. Una posible dirección es explotar



activamente los proyectos educativos y de investigación intergeneracionales. Las conclusiones subrayan que esto contribuirá sin duda a establecer un entendimiento mutuo más eficaz entre el personal docente.

Palabras clave: conflicto intergeneracional, diferencias generacionales, educación, estrategias de enseñanza, innovaciones pedagógicas.

Introduction

Generational conflict is one of the many challenges facing the modern education system. This conflict arises due to rapid social and technological changes that affect the perception of the learning process, teaching methods, and communication.

The current literature suggests that the younger generation of students has grown up in a digital world where information is readily available at any time. In contrast, many teachers continue to employ traditional teaching methods (Siegieñ, 2024).

Accordingly, this development leads to misunderstandings that reduce the effectiveness of the learning process and can lead to demotivation on both sides. At the same time, a significant research problem is the lack of effective methods and approaches to resolving the intergenerational conflict in education (Turabay et al., 2023). This fact leads to a decrease in the quality of education (Lavrysh et al., 2022). The models of pedagogical interaction currently in use often overlook changes in values, perceptions of information, and the level of technological awareness among students. Accordingly, this highlights the need to explore new and innovative approaches, underscoring the relevance of this study.

Despite modern pedagogical research, the issue of intergenerational conflict in education remains insufficiently studied. The shortcomings of modern works include the lack of systematic coverage of methods that affect the integration of traditional and digital educational technologies. Furthermore, the current scientific literature reveals a lack of attention to the psychological aspects of intergenerational interactions. Finally, the lack of qualitative empirical research to analyze the effectiveness of various strategies for overcoming intergenerational conflict is significant.

These scientific gaps determine the need to analyze the implementation of innovative solutions that combine modern digital technologies, adaptive teaching methods, and psychological approaches to intergenerational communication. Therefore, this study aims to empirically investigate implementing modern, innovative approaches to resolving intergenerational conflict.

Additionally, the focus is on assessing the presence of intergenerational conflict in the modern education system and identifying the primary causes of this conflict.

Hence, the primary objective of this study is to examine the causes of generational conflict in higher education, identify current approaches to addressing this conflict, and formulate recommendations for resolving misunderstandings within the higher education system.

To this end, the following tasks have been identified:

- To determine the level of satisfaction with cooperation between different generations of teachers;
- To assess the scale, causes and consequences of the conflict of generations in higher education;
- To define the role of the administration of educational institutions in resolving the conflict;
- To identify the most effective methods of overcoming intergenerational contradictions.

Theoretical Framework

The problem of generational conflict is not new in science. In particular, American researchers Neil Howe and William Strauss have developed a theory of generations, according to which each generation changes

every quarter-century. For example, Generation X (born 1960-1981) was characterized by being responsible and independent in life and decision-making, whereas Generation Y (born 1982-2000) showed less interest in material goods and possessed less knowledge (Arduyan et al., 2022).

At the same time, there are also skeptical assessments of generational theory, as it is challenging to imagine that it can account for all the factors and differences in the world. In addition, studies have primarily focused on the European and American worlds, whereas there is much greater diversity around the globe.

However, no one doubts that the generational gap exists and profoundly impacts work performance (Yun et al., 2022a).

This is also true in education, which has been dramatically affected by digitalization and globalization, along with all aspects of social life. This proposed review aims to assess the current state of research on this issue and identify gaps in existing studies.

Generational Conflict in Educational Settings

Several studies have examined the complex issue of the emergence and evolution of generational conflict in universities and other educational institutions. For example, Van de Velde (2024) has provided a thorough overview of integrating future generations into the educational process, identifying the difficulties new students will face if attitudes towards digitalization do not change. Beytekin & Doğan (2019) have emphasized the difference in approaches to education among academics from Generation X and Generation Y, who, in fact, numerically dominate modern higher education. Hiromitsu (2024a) has proposed innovative methods for resolving existing generational conflicts. However, he notes that it will likely never be possible to completely resolve the potential friction between senior and junior teachers.

In his opinion, the researcher has only offered some universal solutions that deserve attention. Kryvoshein (2023) noted the importance of considering the political component in education development since political will directly affects decision-making at the national level. In particular, this situation is quite typical for Ukraine, as noted by researchers (Kaplia et al., 2024). Undoubtedly, the generational conflict should be taken seriously, as Zahorodna et al. (2022) emphasized, as it can potentially impact the quality and level of education. Regarding learning, problems in the teaching environment will undoubtedly impact the overall university environment.

Management of generational conflicts

The problem of generational conflicts needs to be addressed, as its negative consequences are pretty destructive. The researchers noted that understanding inter-age contacts in the workplace constitutes a critical issue for further research Amah (2024). Understanding the individual aspects of the mechanism that leads to the formation of such conflicts has also been studied (Hillman, 2014). However, the empirical component of the study will also require attention, as these articles often lack measurements and surveys. Hillman (2014) proposed some details for understanding intergenerational conflicts, highlighting the individuality of conflict resolution in multicultural environments. Orhani (2023) noted the influence of educational philosophy on the functioning of educational environments, highlighting the problems that arise due to digitalization.

Researchers have also traced individual manifestations of generational conflict and counteraction to their manifestations (Sobry et al., 2023; Portela Pruaño et al., 2022). Individual proposed solutions are essential for developing future recommendations in the management environment (Rushton, 2024; Trujillo-Torres et al., 2023). Such conclusions are essential for future scientific consideration.



Problems in current studies

At the same time, existing studies on overcoming the consequences of inter-age conflicts in today's educational environment only cursorily reveal individual aspects. In particular, little attention is paid to empirical measurements of the situation in higher education institutions. The potential role of innovative technologies in addressing these issues is also discussed in a fragmentary manner.

Therefore, further development of this topic presents opportunities for a deeper consideration of the role of modern approaches in resolving generational conflicts within the educational sector. Therefore, this article aims to fill the gaps and identify practical approaches to resolving generational conflict in the modern educational system.

Methodology

Research design

The type of this study is quantitative, involving the conduct of a structured survey among teachers and administrators of higher education institutions. This type of study was chosen due to the need to obtain objective, statistically sound data on the emergence and consequences of generational conflict in higher education. In addition, the structured survey contributed to quantitatively determining the role of generational conflict, its causes and consequences. The study was conducted from November 2024 to January 2025.

Sample and Participants

A purposive sampling method was used to include participants using clear inclusion criteria:

1. Teachers or representatives of the administration of higher education institutions were eligible for inclusion.
2. A minimum of 3 years of educational experience.
3. Understanding what generational conflict is and how to resolve it.
4. Utilizing various modern teaching approaches.
5. Providing voluntary consent to participate.
6. Willingness to discuss modern methods of resolving generational conflicts in the educational process.

In the study, participants were selected from among employees of higher education institutions through a request to the administration. Additionally, invitations were disseminated through internal communication channels, including email and internal information platforms. The invitation clearly stated the requirements for participants (inclusion criteria) and the study's primary purpose.

At the same time, a mailing was also sent to teachers through various communication channels. The administration was involved similarly. Additionally, the inclusion of administrative representatives in the study was facilitated through personal contacts. A total of 50 people participated: teachers ($n = 35$) and administrative representatives ($n = 15$). The sample is purposeful (non-probability) and exploratory, which limits the generalization of results, but allows us to identify trends and features relevant for further research. Hence, despite the small sample size, the results allow us to identify primary trends and form the basis for further, broader research. Table 1 presents basic data on the participants.

Table 1.*Data on study participants: group, age, experience and gender*

No	Group	Age (mean $\pm$ standard deviation)	Educational experience (mean $\pm$ standard deviation)	Gender	Specialties
1	Teachers	42 $\pm$ 5	14 $\pm$ 3	M – 60% F – 40%	Pedagogy History Mathematical disciplines Economics International relations
2	Administration	45 $\pm$ 6	16 $\pm$ 4	M – 30% F – 70%	Mathematical disciplines History Economics Management Administration
3	Total	43 $\pm$ 5	15 $\pm$ 3	M – 50% F – 50%	Various specialties

Source: Author's development

Instruments and Procedure

For this study, a semi-structured survey was conducted to explore the role of generational conflict in modern higher education, identify its causes, and assess its consequences.

The survey was carried out in December 2024 in an in-person format. Participants had the opportunity to express their opinions on specific questions freely. Additionally, the developed questionnaire included questions aimed at identifying the most pressing issues related to generational conflict in education and evaluating innovative approaches to addressing them.

The survey was conducted in stages: initially among teachers and later among the administration. The key questions were as follows:

1. How satisfied are you with the current level of cooperation between different generations of teachers?
2. How do you assess generational conflict in the modern higher education system?
 - a) Very low
 - b) Low
 - c) Average
 - d) High
 - e) Very high
4. In your opinion, what are the main reasons for the emergence of this conflict?
5. What is the most significant impact of generational conflict in education?
 - a) Quality of the educational process
 - b) Motivation
 - c) Team atmosphere
 - d) Personal professional development of teachers
6. Are there any methods implemented in your educational institution to mitigate the causes and consequences of generational conflict?
7. Which methods do you consider the most effective in addressing generational conflict?



- a) Interactive teaching methods, further digitalization of learning
 - b) Project method
 - c) Mentoring and coaching
 - d) Conducting training on communication
8. Should the identified modern approaches to resolving generational conflict in higher education be implemented?

Thus, these questions helped identify effective methods for addressing generational conflict and influenced the assessment of its current state in modern education.

Data Analysis

Microsoft Excel software was used for data analysis. This program was chosen for its ability to quickly and efficiently process data and provide a clear graphical visualization.

A thematic analysis was employed to process open-ended questions in several stages. In the first stage, all responses were combined into a single document, from which errors and typos were eliminated. Then, similar responses were selected to apply the coding method, which received short labels based on their content. In particular, the following key phrases were highlighted:

1. Conflicts due to different views on the discipline – *Differences in approaches to learning*
2. Young teachers are more actively using technology – *Impact of new technologies*

This step was crucial for forming a general impression of the results obtained, which was reflected in the textual support for the numerical values. After that, all codes were grouped by content categories and the main themes were identified:

1. *Difference in values*
2. *The role of technology*
3. *Differences in educational approaches or methods*
4. *Conflict resolution strategies*

The survey results were also counted, and specific numerical values were determined. The data were checked and clarified a second time. Each block of questions was described in terms of the task and purpose of the study. The analysis method enabled the interpretation of the results, comparison with the research of other scientists, and the formulation of specific generalizations and recommendations.

Hence, the collected data were processed using descriptive statistics: frequencies, percentages, and averages. To increase the analytical depth, inferential statistical methods were also applied, in particular, the following tools were used to process quantitative data:

- T-test for independent samples - to compare the mean values between two groups;
- Correlation analysis (Spearman coefficient) - to assess the relationship between age, experience, and the level of adoption of innovative strategies.

Ethical principles

The study complied with the basic principles of academic ethics: voluntary participation, anonymity, confidentiality and no harm to participants. Before filling out the questionnaire, all respondents were informed about the aim of the study, the nature of participation and the right to refuse at any stage. Formal consent was obtained by confirming participation in the survey.

Since the study did not involve interference in the personal sphere, did not use vulnerable groups of the population and did not involve risks for participants, no formal appeal to the ethics committee was made. At the same time, the research methodology complies with generally accepted standards of ethical behavior in the humanities and social sciences.

Results and Discussion

In modern education, the conflict between generations is one of the most pressing issues directly affecting the educational process. First of all, there are essential differences in pedagogical values, specific approaches to understanding the essence of education, innovative technologies, and communication styles that can create obstacles in the interaction between students and teachers and promote mutually beneficial development. For this reason, an effective solution to this problem (or at least an approach to such a solution) will significantly contribute to improving education quality, developing innovative educational methods and creating a comfortable developmental environment. One of the most important things is to identify the best solutions to ensure harmonious education cooperation between representatives of different generations.

Therefore, it is essential to identify further innovative approaches, specific methods, and practical recommendations to mitigate the negative aspects of the conflict between generations and evaluate the potential effectiveness among the participants. To begin with, it is essential to establish how satisfied respondents are with the current level of cooperation between different generations (see Figure 1).

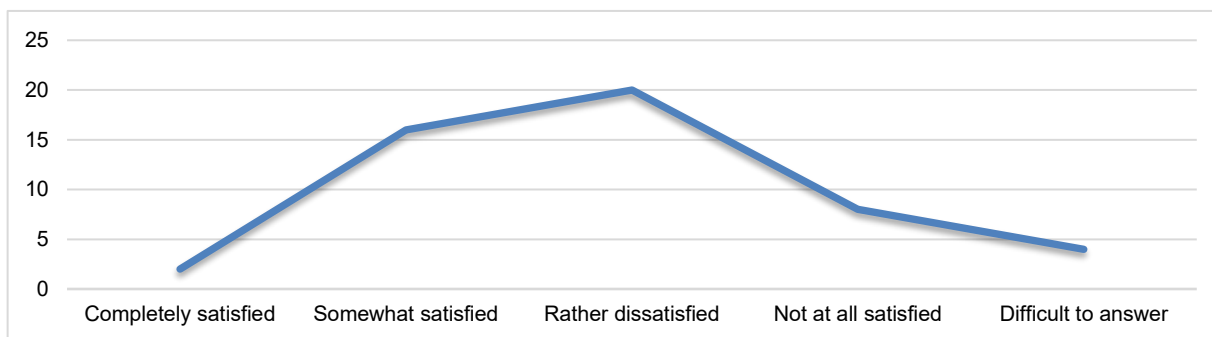


Figure 1. The level of satisfaction with the current cooperation between different generations of teachers
Source: Author's development

The results show that the majority of respondents are somewhat dissatisfied with the current level of cooperation between different generations of teachers (20 respondents, or 40%), which is higher than the number of respondents who are "rather satisfied" (12 respondents, or 32%). It is worth noting that the number of individuals who are completely satisfied with the cooperation between different age groups of teachers is only two people (4%). In contrast, the number of those who are entirely dissatisfied is almost four times higher, at eight people (16%). Four people (8%) could not answer the question. The latter, however, does not mean that they do not feel the conflict between generations. They probably could not define the current level of cooperation in more detail. The respondents were also asked to directly assess the existence of generational conflict in modern higher education (see Figure 2).

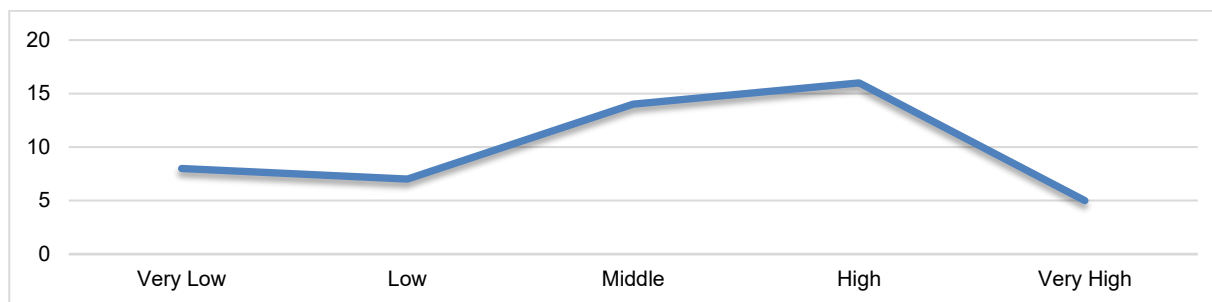


Figure 2. The level of generational conflict in the modern higher education system
Source: Author's development

The respondents determined that the conflict between generations is either “medium” (14 respondents, 28%) or “high” (16 respondents, 32%). According to the Likert scale, this indicator, with a value of “very low” assigned as one and “very high” assigned as 5, corresponds to a value of 3.06. These results demonstrate an above-average value but not a high one. This assessment is further supported by the low number of respondents (only five people, or 10%) who identified such a conflict as highly relevant. However, no respondent scored 0 (“no conflict”), so the intergenerational conflict is present. It is essential to identify its causes (see Figure 3).

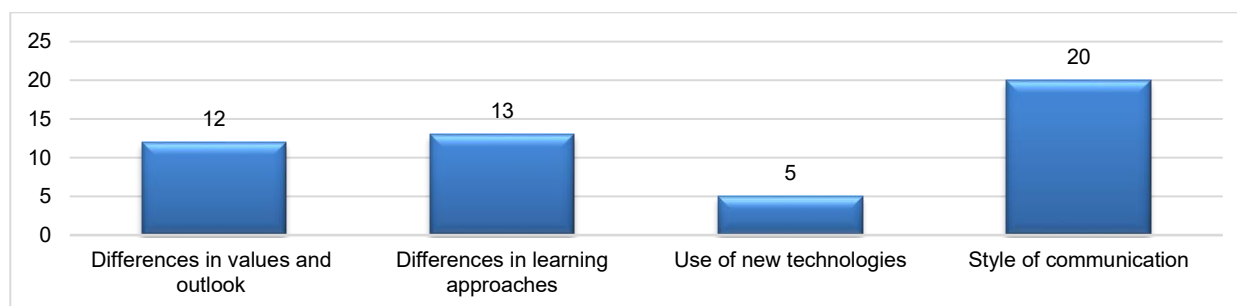


Figure 3. Causes of intergenerational conflict
Source: Author's development

The primary reason for the emergence of generational conflict is the distinct style of communication that is often evident between senior and junior colleagues in higher education institutions. This figure was supported by 20 respondents (40%). The reasons for this are the differences in values and worldviews between young and older teachers and different approaches to organizing and envisioning the ultimate goal of education, which are approximately equal. The lowest indicator is the use of new technologies, with five respondents (10%). Obviously, due to the Russian armed aggression against Ukraine and the widespread adoption of distance learning, which has been exacerbated by the effects of the COVID-19 pandemic and related quarantine restrictions, almost all teachers, regardless of age, have acquired sufficient skills to utilize at least some digital tools in the learning process.

Respondents identified the threat of intergenerational conflict (see Figure 4). Respondents identified that the most significant negative impact of the generational conflict among teachers is seen in the quality of the educational process (17 people, or 34%). The problem of deterioration of mutual understanding within the teaching team is somewhat less significant, affecting 15 respondents (30%). Negative manifestations that harm motivation were noted by 11 people (22%). On the other hand, the least negative impact of the generational conflict was recorded in personal professional development, noted by only seven respondents (14%).

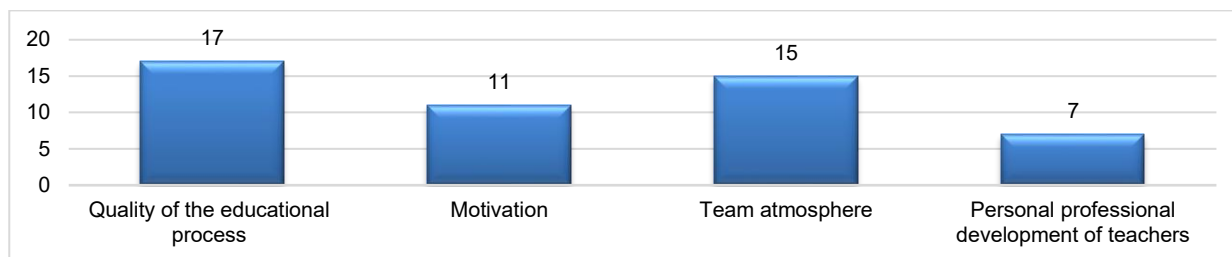


Figure 4. The influence of the existing conflict of generations in education

Source: Author's development

The survey participants were asked to move beyond identifying the shortcomings to determining the participation of educational institution administrators in addressing this conflict (see Figure 5). The survey results showed that the administration of residential institutions generally understands the importance of addressing the consequences of intergenerational conflict.

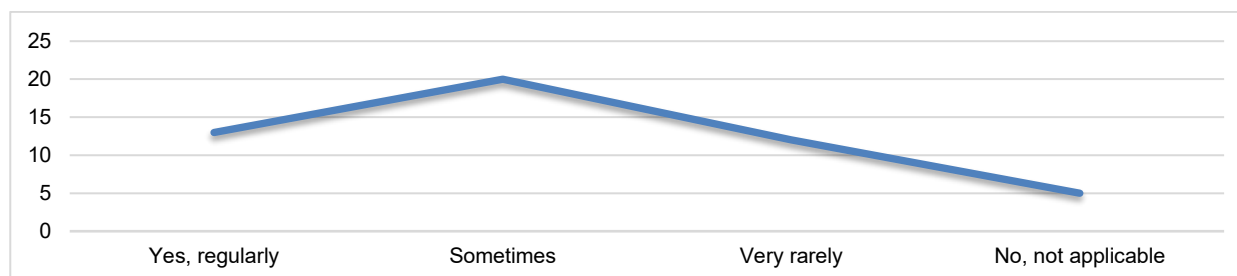


Figure 5. Implementation of methods for overcoming the consequences and causes of intergenerational conflict

Source: Author's development

In general, 33 respondents positively identified the administration's desire to influence and prevent the consequences of the generational conflict. Of these, 13 (26%) noted the regularity of such measures, and 20 (40%) said such measures are implemented occasionally. On the other hand, 17 teachers surveyed indicated that the administration's response would require a broader impact: 12 (24%) reported rare cases of intergenerational conflict resolution, and 5 (10%) denied any attempts to resolve such conflicts. Although this unsatisfactory rate of intergenerational conflict resolution remains relatively high, it is essential to define better which methods of resolving intergenerational conflict can be considered the most effective (see Figure 6). The respondents primarily mentioned joint projects by teachers of different ages as a good example of conflict resolution (21 people, or 42%).

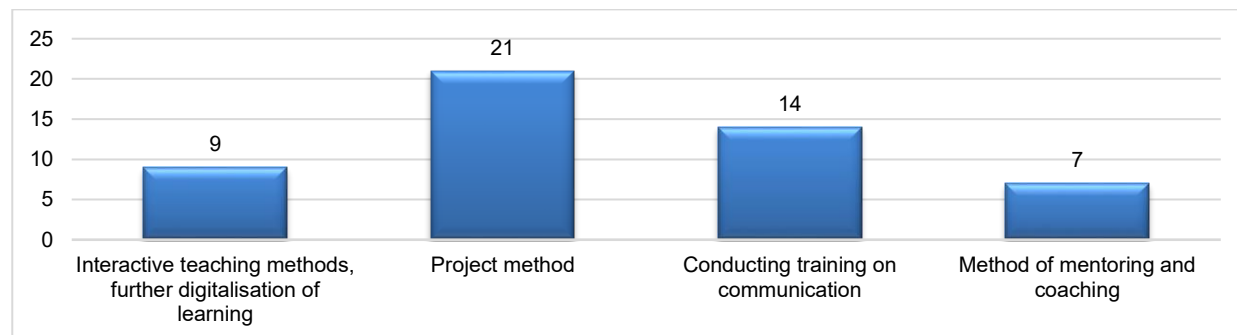


Figure 6. Effective methods of addressing intergenerational conflict

Source: Author's development

The respondents were guided by the idea that working on familiar topics and tasks would significantly reduce tensions and eliminate the lack of appropriate communication. Special psychological and communication training was positively assessed by 14 people (28%). The maximum distance between teachers facilitated through digital means of organizing the educational process was identified by nine people (18%). Only six respondents (12%) consider using mentoring and coaching to be effective.

Even though the administration has, on average, more work experience (16 ± 4 years versus 14 ± 3 years for teachers), both groups demonstrate a moderately high level of awareness of intergenerational conflict. To identify possible differences in satisfaction with intergenerational cooperation, a t-test for independent samples was conducted (Table 2). The results showed a statistically significant difference between teachers and administration ($t = -3.29$, $p = 0.0019$), indicating a significantly lower level of satisfaction among teachers.

In addition, a Spearman correlation analysis was conducted to determine the relationship between age, work experience, and the assessment of the level of intergenerational conflict (Table 2). A moderately strong positive correlation was found between age and the assessment of conflict ($p = 0.67$, $p < 0.0001$) and between experience and the assessment of conflict ($p = 0.71$, $p < 0.0001$). Such indicators showed that with age and accumulation of experience, the subjective perception of conflict increases.

Table 2.

Comparative and correlational analysis of demographic and behavioral variables

Analysis	The meaning of statistics	p-meaning	Description
t-test (satisfaction level: teachers vs. administration)	-3.29	0.0019	There is a statistically significant difference between the groups
Spearman correlation (age ~ conflict score)	0.67	0.00013	Moderate positive correlation; significant relationship
Spearman correlation (experience ~ conflict score)	0.71	0.00015	Moderate positive correlation; significant relationship

Source: Author's development

At the same time, using digital technologies should not be seen as an opportunity to deepen the age gap. In organizing the educational workload, it is necessary to incorporate technologies that enhance communication rather than exacerbate isolation. For example, tools and platforms such as Google Workspace or Microsoft Teams can be mentioned. Although mentoring was the least popular in the survey, there is a need to improve this practice, including by increasing the motivation of teachers to participate in mentoring programs. Generational conflict as a research concept is not a new phenomenon in science. However, in recent years, significant transformations have occurred due to the rapid digitalization of the educational process, which also impacts the relationships within the teaching staff. There are problems with establishing cooperation in the new conditions, specifically in finding common access points between specialists of different categories and varying teaching experiences.

This proposed article aims to analyze modern approaches to resolving the intergenerational conflict in education, examine specific innovations, and formulate practical recommendations. Consideration of such a general problem involved the analysis of other tasks as well: to characterize the presence of generational conflict in the higher education system (to what extent the participants of the educational process independently determine its importance), to define the essence of generational conflict, to identify the most effective innovative methods of counteracting generational conflict and to formulate recommendations for overcoming it. The proposed results indicate that most respondents are dissatisfied with the current level of cooperation between different generations of teachers, with only 4% of respondents fully satisfied with cooperation between different age groups of teachers. The survey analysis also revealed that respondents assessed the conflict between generations as 'medium' (28%) or 'high' (32%). According to the Likert scale, the analysis of all indicators yields a value of 3.06, indicating an above-average result.

The findings confirm the conclusions of other researchers, who have pointed to the presence of intergenerational conflict in educational institutions to varying degrees of severity (Drury & Fasbender, 2024; Orte et al., 2017). Usually, however, a moderate level of conflict is indicated, which, in terms of the Likert scale, can also be determined in the range of 3.00-3.10 (Yun et al., 2022b), correlating with the proposed study results. Moderation of conflict is rightly associated with a high degree of respect for older teachers and younger conservative employees, as colleagues who may have a different point of view but are committed to doing their job well (Hiromitsu, 2024b; Dere & Başibüyük, 2024). The ethical aspect of this plays a vital role, although this does not negate the existence of a generational conflict, as acknowledged by respondents.

The results also demonstrate the essence of the generational conflict in education. Respondents noted that the primary reason for the emergence of generational conflict is the style of communication that is often evident between senior and junior colleagues in higher education institutions (40%). The reasons for this are the differences in values and worldviews between young and older teachers and different approaches to organizing and envisioning the ultimate goal of education.

The lowest indicator is the use of new technologies. There is also an understanding of the overall negative impact of generational conflict on the organization of the educational process, particularly in the educational context. There is also a negative impact on mutual understanding within the teaching team and on maintaining motivation. The results align with the findings of other researchers (Ahsan et al., 2022; Urlick et al., 2016).

In particular, researchers note that the issue of communication between different generations is a classic problem not only in the university environment but also in society as a whole (Zhang & Wiebe, 2022; Madhavan et al., 2023). Obviously, with the growth of digitalization, this process has intensified, necessitating an appropriate response.

Researchers have also concluded that the conflict between generations is typically assessed from a negative perspective (Moreno Abellán et al., 2022; Dzhym et al., 2023). However, some researchers' views diverge from this general concept, arguing that opportunities exist for conflict resolution and development (Yeung et al., 2021). The concept of response is entirely subjective and requires numerous conditions for implementation, a point also emphasized in research (Rushton et al., 2023). The following empirical studies will allow us to consider this issue more thoroughly.

The results demonstrate that the administration of residential institutions generally understands the importance of overcoming the consequences of intergenerational conflict. Thus, most respondents noted that educational institutions' administrations are ready to counteract the effects of intergenerational conflict. The findings confirm the conclusions of other researchers who note the importance of establishing quality interaction between teachers and other participants in the educational process to overcome generational conflict (Thoilliez & Wortmann, 2024).

The proposed results also indicate some methods of resolving intergenerational conflict that should be considered the most effective, including joint projects of teachers of different ages as a good example of conflict resolution, special psychological and communication training, the use of digital tools for organizing the educational process, and the use of mentoring and coaching. Similar methods, but in a different order, have also been mentioned by other researchers, emphasizing their relevance and effectiveness (Ferrare & Phillippo, 2021; Kurebay et al., 2023). The actual difference with the results obtained is that researchers mainly recognize mentoring or coaching as second only to joint projects (Vanblaere & Devos, 2021). This is due to the need for effective communication, which facilitates discussion of important issues, exchanging experiences, and more. The method's significantly lower popularity in Ukrainian realities can be attributed to formalization and excessive bureaucracy (Sokol & Melko, 2022). Overcoming the excessive bureaucratization of the process will allow us to rethink the benefits of using this approach.



The study results indicate that, even though administrative staff have somewhat more experience in the educational field than teachers (16 ± 4 years versus 14 ± 3 years), both groups showed a moderately high awareness of intergenerational conflict. This confirms the findings of several previous studies, which indicate that the acquired experience is not always the basis for reducing intergenerational tension, since the conflict may be associated not only with professional experience, but also with profound cultural and value differences (Hillman, 2014; Madhavan et al., 2023).

In addition, the t-test can reveal a statistically significant difference in the level of satisfaction with intergenerational cooperation: teachers are significantly less satisfied with this aspect than the administration. This is consistent with the results of other studies that show that teachers, especially the younger generation, more often feel misunderstood and undervalued by management, which can increase the feeling of intergenerational conflict (Sobry et al., 2023).

Correlation analysis allowed us to indicate that with age and accumulation of experience, the subjective perception of intergenerational conflict increases. This may be because older workers have more established values and stereotypes, which conflict with the views of younger colleagues, who are oriented towards innovation and change. At the same time, the results indicate the need to implement specialized training and programs that will contribute to better mutual understanding and reduce tension between generations, which is in line with the recommendations of modern pedagogical literature. Hence, some recommendations based on the survey results are also proposed.

In particular, it is proposed that elements of teamwork be incorporated into everyday tasks. This will help establish a more effective mutual understanding among the teaching staff, foster cooperation with students, and reduce tension during communication. A possible option is to actively engage in intergenerational educational and research projects that bring together representatives from different age groups of teachers, along with the involvement of graduate students and undergraduates. Special psychological and communication training is relevant and should be organized continuously.

Given that the administration of educational institutions is aware of the need to overcome the consequences of intergenerational conflict, attention should be paid to the mechanism of regular involvement of professional psychologists. These recommendations align with the broader vectors for overcoming the intergenerational conflict proposed by other scholars (Chandler, 2018). However, they also refer to the specifics of work in Ukraine, where the implementation of joint projects can be considered more promising than attending formal educational training.

The methodology employed in this study has its limitations, which should be considered when interpreting the article's results. First of all, it should be noted that a survey is a relatively subjective method of collecting information, as it relies more on the personal experiences of respondents, who may not have a comprehensive understanding of the situation in the educational institution as a whole. A similar problem is also associated with the use of the Likert scale. At the same time, the proposed limitations do not affect the overall state of the work, as the information collected demonstrates the general directions and views of the respondents.

Conclusions

The generational conflict poses a significant challenge for the modern education sector, as the rapid development of technology, changes in communication, and the speed of information processing can be problematic for many conservative teachers. It was found that most respondents are somewhat dissatisfied with the current level of cooperation between different generations of teachers. However, respondents rate the conflict between generations as 'moderate' or 'high', corresponding to a score of 3.06 (above average) on the Likert scale.

The moderation can be attributed to the high respect for older teachers, young conservative employees, and others. This ethical aspect plays a vital role, although it does not negate the existence of a generational

conflict. The essence of the generational conflict in education is also demonstrated. For example, it was noted that the biggest reason for the emergence of generational conflict is the communication style. The influence of factors such as the differences in values and worldviews of young and older teachers and varying approaches to the organization and vision of the ultimate goal of education is described at approximately the same level. The survey results show that all participants in the educational process recognize the negative impact of generational conflict on the organization of the educational process, mutual understanding within the teaching team and maintaining motivation.

Administrative staff of educational institutions generally understand the importance of overcoming the consequences of generational conflict. There are several innovative methods for resolving the conflict between generations, including implementing joint projects for teachers of different ages, conducting specialized psychological and communication training, utilizing digital tools to organize the educational process, and applying the methods of mentoring and coaching.

Among the recommendations, it is worth emphasizing the need to incorporate elements of teamwork into everyday tasks. This will help establish a more effective mutual understanding among the teaching staff, foster cooperation with students, and reduce tension during communication. Another option is to engage actively in intergenerational educational and research projects. Special psychological and communication training is also relevant and should be organized regularly.

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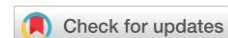


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.14>

Cómo citar:

Boiarynova, I., Tsarova, Y., Storozhuk, V., Havrylenko, O., & Karskanova, S. (2025). Developing consulting competence in the digital educational space: An experimental study in higher education. *Revista Eduweb*, 19(2), 199-219. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.14>

Developing consulting competence in the digital educational space: An experimental study in higher education

Desarrollo de la competencia de consultoría en el espacio educativo digital: un estudio experimental en la educación superior

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Recibido: 08/05/25

Aceptado: 25/06/25

Abstract

The concept of "consulting" and its application in educational settings are explored, along with the functions performed by consulting in the educational sector. The effectiveness of information technologies in consulting activities is proven. A new type of consulting in the consulting services market is considered – information



technology consulting. The main goals of modern information technologies in consulting activities are revealed. The main tasks of modern information technologies in consulting activities are grouped. The main components of the application of modern information technologies and the main tasks of consulting service specialists are identified. The content of applied information, digital technologies, and ways of their application in consulting during distance learning are revealed. The experimental study was conducted by a specially developed program based on the methodology for forming consulting competence in the modern information educational space of future specialists in the process of professional training. The experimental data obtained on positive changes in the formation of consulting competence, its components in future specialists, give grounds to speak about the effectiveness of the experimental methodology in the process of professional training.

Keywords: consulting competence, information digital technologies, educational industry, consulting services, management competence.

Resumen

Se revela el concepto de "consultoría" y el contenido de las actividades de consultoría en educación; se consideran las funciones que desempeña la consultoría en el sector educativo. Se demuestra la eficacia de las tecnologías de la información en las actividades de consultoría. Se considera un nuevo tipo de consultoría en el mercado de servicios de consultoría: la consultoría en tecnologías de la información. Se revelan los principales objetivos de las tecnologías de la información modernas en las actividades de consultoría. Se agrupan las principales tareas de las tecnologías de la información modernas en las actividades de consultoría. Se identifican los principales componentes de la aplicación de las tecnologías de la información modernas y las principales tareas de los especialistas en servicios de consultoría. Se revela el contenido de las tecnologías de la información aplicadas y digitales, y las formas de su aplicación en la consultoría durante la educación a distancia. El estudio experimental se llevó a cabo de acuerdo con un programa especialmente desarrollado, basado en la metodología para la formación de competencias de consultoría en el espacio educativo de la información moderna de futuros especialistas en el proceso de formación profesional. Los datos experimentales obtenidos sobre los cambios positivos en la formación de la competencia de consultoría y sus componentes en los futuros especialistas permiten hablar de la eficacia de la metodología experimental en el proceso de formación profesional.

Palabras clave: competencia consultora, tecnologías de la información y digitales, sector educativo, servicios de consultoría, competencia gerencial.

Introduction

In the modern education system, transformations and global changes are taking place due to the constant adaptation of a person to the conditions of the external environment. The development of the educational sector is carried out under the influence of such social, economic, and technological transformations that are constantly taking place in the global educational space. That is why traditional education cannot fully meet the needs of society and is unable to respond promptly to acute problems that arise in the world.

The active development of a modern digital society in the world necessitates the use and implementation of consulting in the educational sphere at a professional level, which contributes to the provision of high-quality educational services, contributes to the development and support of an educational institution, and ensures the quality of education. One of the most important conditions for the successful functioning of educational institutions is their ability to develop rapidly in the conditions of a progressive market and global changes.

Educational institutions, to maintain their vital activity, are forced to restructure, introduce innovative technologies, constantly evolve, and improve, which requires knowledge and skills, and a lot of effort from management personnel. At the current stage of development of society, it causes complications of socio-economic processes; therefore, there is a need to transfer skills, experience, knowledge, and methods of management of economic relations to an independent sphere, which in turn contributes to the formation of the international and national consulting market. (Drahunova, 2023).



Therefore, ensuring high-quality consulting activities in the modern information educational space is a relevant requirement today all over the world, because today the reform of the education system is aimed at ensuring the compliance of the quality of professional education with the needs of the country's development and the demands of modern life. In this process, consulting services play an important role in the field of assessing the quality of education.

Literature Review

The theoretical foundations of consulting practice, the institutional structure of the global market, and the specifics of the functioning of its various segments, the formation of the global competitive environment, and key trends in the development of the global consulting market are revealed in the works of various domestic and foreign scientists.

Analysis of scientific literature on the content and essence of the concept of "consulting", ensuring high-quality consulting activities in the modern information educational space, makes it possible to assert that many scientists have studied this issue. The essence of consulting activities in a higher education institution is revealed by Drahunova (2023). A scientific and theoretical analysis is carried out, and the main requirements for the implementation of consulting activities in a higher education institution are determined. The main functions of consulting are highlighted, and the areas of cooperation between higher education institutions and consulting companies are characterized. In the modern educational activity of a manager of a higher education institution, the importance of management consulting has been proven, especially in the context of global challenges, such as mobility, internationalization, diversification, democratization, etc. The essence of consulting management in education is revealed, which is a reliable mechanism for meeting the needs of subjects of educational activity of a future specialist, aimed at improving the quality of management activities and ensuring the competitiveness of higher education institutions.

Research by foreign and domestic scientists and practitioners is devoted to the issues of consulting practice, in particular, the development of consulting practice, consulting methods and techniques, as well as the marketing of consulting services. The definition of consulting as a specific type of joint intellectual activity of the client and the consultant is given by Khomenko (2020). The consulting function consists of identifying and analyzing the set of management tasks; assisting in solving management problems; developing proposals for solving management tasks; in monitoring the effectiveness of the implementation of proposals and necessary practical measures. The content of the consulting component in the management of an educational institution is revealed by Chepurensko (2024). The researcher, in the conditions of public-private partnership, showed the influence of educational consulting technologies and management consulting on the efficiency of managing a vocational education institution; identified the types of consulting that must be used in the process of implementing projects and developing public-private partnership projects. It is shown that the consulting competence of the head of an educational institution will affect the quality of the application of public-private partnership technologies and the development of the educational institution itself.

Finding ways to solve the problems of consulting practice is given considerable attention by specialists in the field of automation, creation, and implementation of information and communication technologies in education, pedagogy, and psychology, theory and methodology of teaching computer science, who highlight valid opinions on this problem in their works. In particular, scientists Holovnia et al. (2023) see the consulting component in the management of an educational institution in connection with digitalization, which is a direction of development that is mandatory for any sphere of human activity in the modern world. Scientists have characterized the process of digitalization in higher education institutions, identified the main problems that arise, and the impact of the digitalization process on teaching activities. It is noted that the formation of digital competence of teachers and increasing the insufficient level of technical support, the gap between students and teachers in technical support, and eliminating ignorance of the potential capabilities of various digital tools significantly reduces the effectiveness of the educational process and requires active support from the administration of educational institutions.



In turn, scientists from Latin American countries consider the problem of consulting practice in the information space and draw attention to the importance of innovative technologies in this practice. According to scientists from Latin American countries, attention is focused on the need to use innovative technologies throughout the educational process, which will allow the formation of a high information culture of the world's youth. The formation of innovative technologies in consulting activities in the information space requires, first of all, a high level of information culture and methodological literacy of the specialist.

In the work Caramori (2016) presents part of the results of a research with a qualitative approach grounded on the participatory and interpretative perspective. It aims to offer regular and special education teachers in service continuing training on the collaborative consulting approach.

Scientists Gerlin et al. (2019) revealed the information literacy learning program: networks of collaboration between people working in information, educational, and cultural spaces.

The aim of the article by Zattar et al. (2024), is to shed light on the concept of information education from a terminological and conceptual perspective. To this end, the article examines the understanding of the term "information education" in the field of information studies from a linguistic perspective. This discussion examines the social perspective of information to the extent to which education can contribute to critique.

However, the issues of designing web-oriented information systems for managing the educational process of a university and their systematic implementation and use in the information, educational, and scientific environment of higher education institutions remain insufficiently developed.

Theoretical analysis of the current state of scientific research and practical aspects of the use of ICT for the organization and management of consulting practice indicates the presence of contradictions between:

- The objective need of society to update the educational process management system to improve the quality of training of future specialists in consulting practice, and the insufficient development of its conceptual, scientific, and applied provisions;
- The rapid growth of the influence of information technologies on all ongoing processes, and the lag of theoretical and methodological research on the systematic use of ICT tools in consulting practice;
- The available technological capabilities of using modern information and communication technologies to support the educational sphere, in particular web-based and cloud-based technologies, and the insufficient readiness of participants in the educational process of higher education institutions for their scientifically based, pedagogically balanced, and effective use;
- The significant didactic potential of using information systems in Consulting practice, and the lack of theoretically based models and effective methods for their design and implementation.

At the same time, the problems of consulting services are not comprehensively covered and remain poorly researched, and their solution is often limited to practical recommendations, so many issues are not considered and require study in both theoretical and applied aspects.

Yes, there is no research focused on studying and improving the conceptual foundations of marketing consulting services, which would ensure the success of market activity.

The key characteristics of the concept of partner marketing are most capable of ensuring the achievement of such important factors of effective consulting practice.

Therefore, focusing on the importance of consulting practice in the information space is necessary for the formation of an appropriate mechanism of affiliate marketing.

Thus, the range of relevant factors for the effectiveness of the developed methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training is outlined. All this led to the choice of our article.

Research purpose. To prove the effectiveness of the developed methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training.

Methodology

The methodological principles of the study are: leading provisions of the theory of scientific knowledge; general scientific principles of historicism, systematics, scientificity; conceptual provisions of pedagogical, psychological, sociological sciences; ideas of experience based on the synchronous study of pedagogical, socio-cultural and economic phenomena; philosophical and pedagogical ideas of the development of modern information education.

To achieve the set goal, the following research methods were used: theoretical: systematic and targeted analysis of the literature – in order to clarify the conceptual apparatus of the study and compare different scientific views on the problem of the formation of consulting competence; generalization of the practice and theory of professional training of future specialists in order to identify the features of the formation of consulting competence in them; empirical: pedagogical targeted observation of students' activities in the learning process during the study of professional disciplines; diagnostics (questionnaire, interview, survey) – to assess the levels of formation of students' consulting competence; pedagogical experiment – to verify the effectiveness of the developed methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training; statistical – to establish the exact reliability of the experimental results obtained.

The implementation of the pedagogical experiment was carried out in three stages: preparatory, main, and final.

At the preparatory stage, the purpose and objectives of the study were determined, the experimental plan was developed, methods of measurement and processing of the results were identified, control and experimental groups were selected, and their homogeneity was checked.

At the main stage, the experiment was conducted.

At the final stage, the results of the experiment were analyzed, their reliability was confirmed, and conclusions were drawn about the pedagogical effect of the experiment.

The reliability and validity of the obtained results, the objectivity of their assessment were ensured by the methodological justification of the initial positions and the qualimetric mechanism for assessing the quality under study, the use of a complex of complementary research methods, and the involvement of a group of respondents from a higher educational institution in the analysis of its results.

To assess the homogeneity of the experimental and control data collection, statistical processing was carried out using MS Excel and SPSS (Statistical Package for Social Science) programs.

In our article, we used quantitative methods of data analysis. This group of empirical research methods includes methods of obtaining information about the object under study that allow identifying its quantitative characteristics.

When determining the sample of subjects, the general specificity of the research subject was taken into account. The total sample size was 90 subjects. EG included 48 students, CG – 42 students. A representative sample was made up of parallel control groups and experimental groups in the study. When



forming the sample, the criteria of content, representativeness, and equivalence were taken into account. The sample was formed by random selection using the technical procedure of calculating the selection step.

The experiment was conducted in Professional Pedagogical Specialty College of Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Central Ukrainian National Technical University. The conduct of the experiment is permitted by the scientific councils of the universities in order not to violate ethical considerations in institutions of higher education.

The experimental research program included the following actions: outlining the tasks of the experiment for a specific purpose; determining the time and place of the experiment, its volume; characterization of the groups and sample involved in the experiment; description of the methodology for experimenting; description of the materials for experimenting; characterization of the variables influencing the results of the experiment; description of the interpretation and processing of the results of the experimental study.

The pedagogical experiment to verify the effectiveness of the developed methodology for the formation of consulting competence in the modern information educational space of future specialists was carried out in three stages: preparatory, practical, and final.

Methods of probability theory and mathematical statistics were used as the basis for processing the results of the experiment, in particular, the calculation of Student's t-criterion.

We were guided by the basic provisions when choosing diagnostic methods regarding reliability, validity, objectivity, and pedagogical measurements.

The confirmatory experiment conducted using interviews with students, questionnaires, and statistical processing of the results made it possible to state that at the 97% level, the difference between the probability samples of the confidence interval, which were the control and experimental groups, is within 5% and is statistically insignificant, i.e. the difference between the estimates of the levels of formation indicates an almost identical general level of formation of consulting competence in the modern information educational space of future specialists of the control and experimental groups (28% of EG respondents and 30% of CG respondents showed a low level of consulting competence, which made it possible to determine methods for increasing consulting competence in the modern information educational space of future specialists and to develop a methodology for the formation of consulting competence.

The formative experiment in the implementation of the methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training contributed to a qualitative change in the indicators of the phenomenon under study in the experimental groups.

The obtained experimental data on positive changes in the formation of consulting competence, its components in future specialists, give grounds to speak about the effectiveness of the experimental methodology in the process of professional training.

Using the methods of mathematical statistics, the confirmed generalization of the results of the pedagogical experiment, in particular, its formative stage. Student's t-criterion showed significant differences in the levels of formation of consulting competence of future specialists in the process of professional training in qualitative and quantitative indicators.



Results and Discussion

The content of concept of "consulting" and the content of consulting activities in education, functions performed by consulting in the educational industry.

Effective consulting activities in education are a reliable mechanism for ensuring the competitiveness of educational institutions and meeting the needs of subjects of educational activity, aimed at improving the quality of management activities in modern educational institutions.

As an organization of management activities, consulting activities are characterized by four positions in education. Let us reveal these positions:

- 1) Work in an educational institution as a whole (type of institution, operating mode, mission, strategy);
- 2) Activities of subjects of the educational process (technologies of the educational process, design of activities, scientific activity, workload, advanced training of specialists);
- 3) Work of applicants for the educational space (taking into account the individual characteristics of the student, level of education);
- 4) Management structures (technologies, design of activities, functions, organizational structures).

Consulting management is not fully implemented in the higher education system, which necessitates the design of the outlined activities. The subjects of educational consulting activities in the management of socio-pedagogical systems and the general theory of management are managerial, pedagogical employees of higher education institutions, scientific and pedagogical personnel, and public organizations that participate in the design, development, implementation, and application of educational consulting. The object is the activity of managerial, pedagogical, scientific, and pedagogical employees with the use of educational consulting, that is, consulting educational activities without which the existence of higher education institutions is impossible (Drahunova, 2023).

Let us describe the diverse functions performed by consultants in the educational sector. Among them, the most significant are:

- **Scientific function** – contributes to the dissemination of promising management experience and modern scientific achievements;
- **Consulting function** – assists in the analysis and identification of set management tasks; implementation of necessary practical measures; solution of certain management problems; development of proposals for their solution; monitoring the effectiveness of the implementation of proposals (Khomenko, 2020);
- **Intermediary** – search and selection of business partners, establishment and identification of connections with subjects of cooperation; for investment in the activities of an educational institution, identification of useful objects of cooperation;
- **Research** – identification of patterns, factors, and factors that have a direct impact on an educational institution;
- **Educational** – improvement of professional qualifications of specialists, formation of management experience and new skills in them to ensure the development of consulting competence (Skrypnyk, 2021);
- **Social function** – ensuring the interaction of elements of the social system in the context of the development and formation of the human resources potential of society, scientific, intellectual, technical innovation, mutually beneficial and long-term cooperation between educational institutions and private enterprises;
- **Managerial function** – ensuring the functioning of the management infrastructure and its organization in education; ensuring the implementation of an effective management cycle, forming the basis for making appropriate management decisions;

- **Communicative function** – ensuring appropriate interaction with participants-partners of the educational process;
- **Epistemological function** – understanding the patterns of development and functioning of the partnership, which is what consulting activities in education are focused on, to develop appropriate recommendations;
- **Practical and applied** – providing partners in consulting activities in education with recommendations that, through the adoption of certain management decisions, contain measures to achieve the corresponding common goal;
- **intermediary function** – identifying promising objects of cooperation in the educational system, selecting business partners, providing consultations (Díaz et al., 2015).

Types of consulting in the implementation of educational consulting in the management of educational institutions.

Educational consulting in the management of an educational institution is implemented by types of consulting that will ensure the effective organization of the educational process:

- Evaluation consulting, manifested about a specific enterprise in assessing the feasibility of partnership activities, the rationality of risk distribution between partners and resources, prospective and real demand for employees in the labor market;
- Diagnostic consulting, helps to identify the nature and causes of various problematic situations regarding the provision of human resources to the educational process, the introduction of innovative teaching technologies, the possibility of developing the human resources potential of an educational institution, the material, technical and financial capabilities of the educational institution to implement a partnership project;
- Expert consulting allows for the elimination and identification of inappropriate educational and management technologies to carry out a full or partial examination of the implementation of the partnership project, as well as for the introduction of innovative technologies into the partnership project (information and communication, new educational, and innovative technologies);
- Methodological consulting, focused on the development of specific methodological recommendations, the implementation and preparation of certain methods of managing educational institutions under partnership conditions;
- Psychological consulting helps the head of an educational institution, provides a favorable psychological climate of partnership;
- Corrective consulting provides the head of an educational institution with the competence to analyze management situations, implement adaptability and flexibility of management decisions, and select management mechanisms by joint partnership activities (Plakhotnik et al., 2022).

Educational consulting and its management component at all stages of the partnership project are important tools for quality education. It is based on consulting competence, the use of consulting technologies by the manager, which contributes to the practical implementation and understanding of consulting services, the ability to organize management activities with the involvement of experts, conducting and independent assessment of cooperation of a management audit of an educational institution with a private partner (Chepurensko, 2024).

Information technologies in consulting activities.

Today, a new type of consulting has emerged in the consulting services market – information technology consulting. All services for this type of consulting are quite promising, due to the growth in demand for information technology and information technology.

Let's reveal the main goals of modern information technologies in consulting activities:

- Dissemination of knowledge, information about best practices, new technologies, educational achievements, and market conditions;
- Solving several technological problems in consulting services or directly at enterprises that could not be solved earlier due to the lack of computer technology;
- Using the capabilities of the Internet, ensuring access of educational institutions to electronic information sources;
- Automation of the activities of consulting groups;
- Operational exchange of information between consultants and students via e-mail (Crysdian, 2022).

Let's reveal the main goals of modern information technologies in consulting activities: organizing monitoring, creating conditions for the effective functioning of the market, providing information support on issues of professional activity, and forecasting market conditions.

According to applying modern information technologies, the main tasks of consulting services specialists are to create and develop a system of information support for participants in the educational process, the main components of which should be:

- Distribution, systematization, and formation of information resources to ensure the conditions for transparency of the educational environment;
- Support and development of distributed business data banks of professional information;
- Systematization and development of computer technologies of information support, in particular, on issues of analysis, accounting, planning, reporting, and document flow;
- Support and development of automated workplaces of specialists;
- Adaptation of systems that provide electronic information interaction of market formations with consulting structures (Lai et al., 2024).

Consultant specialists must be fluent in the main typical software packages for working on personal computers and be able to navigate modern information systems.

For effective consulting activities, special attention should be paid to the creation and maintenance of market information of regional databases, scientific and technical. These databases should become a fund that is reference and informational and contains scientific, technical, and market information – retrospective (archive), current (operational), prospective (forecast), and meet the following user requirements:

- Be updated promptly;
- Be a means of disseminating information operationally;
- Provide access to the information contained in it in an easy form;
- Include general-purpose information resources – information for general use (legislative, regulatory, and other) (Lahav et al., 2020).

Applied information, digital technologies, and their application in consulting in distance learning.

In consulting, applied information technologies include technologies that solve applied problems of information support of educational activities. These technologies will provide personnel training, information support of an educational institution, automation of management accounting, automation of accounting, dissemination of scientific and technical information, etc.

The limited time of students is one of the most difficult aspects of conducting training in consulting, as well as the high cost of educational activities, which is associated with the costs of food, accommodation, and transportation costs, etc. Therefore, the consulting service is constantly looking for new opportunities in the provision of educational services. Distance learning is an effective method of learning in such a situation (Semenikhina et al., 2020).

An important element that increases the effectiveness of using information technologies is the convenience and simplicity of the "personal computer–user" interface. This allows non-professionals to easily master the use of basic software, develop application packages. The development of the use of information technologies has led to the development of information systems that solve management problems, and the introduction of information support into the educational process (Maslak & Vasylenko, 2018).

Digital technologies are widely used both at work and in the educational process. Now every modern person is a "digital person", for whom digital technologies in everyday life and professional activities are an integral part. Digital technologies have existed for decades and continue to develop intensively. (Gitahy et al., 2016).

Currently, innovative digital technologies are being developed and implemented in the educational process, these are artificial intelligence, augmented and virtual reality, robotics, "smart systems", the Internet of Things, etc. When digital technologies are combined with professional activities, educational activities, humanitarian, social, and other technologies, there is an opportunity, including "digital" education, to implement a "new reality" (Varzhanskyi, 2020).

Therefore, the teaching process and the process of acquiring knowledge must be ready to respond to the latest challenges of the time, and not only meet modern requirements for the quality of education. At the beginning of the 21st century, the digitalization of the educational process and its application in consulting are increasing all over the world. At the World Economic Forum in Davos, the most promising digital technologies were identified: artificial intelligence, cloud technologies, blockchain, mobile technologies, biometric technologies, augmented reality, virtualization, and additive technologies (3D printing) (Prieto Taborda et al., 2019).

One of the main advantages of using digital technologies in the process of ensuring high-quality consulting activities in the modern information educational space is that the teacher can not only control the effectiveness of learning in an applied sense, but also the amount of time spent on solving a specific task, the speed of assimilation of material, and the level of perception of new information. Teachers can be freed from a significant mass of paper documents thanks to online technologies. Students can exchange thoughts and ideas, work in a group on any project. The informatization of education will allow for to provision of free access to any educational content on the Internet (Holovnia et al., 2023).

There is a wide variety of test tasks for students, there is more free time for quality preparation for classes, reviewing incomprehensible parts of new material, which is a significant aspect that positively affects the level of success of all educational institutions in terms of distance learning, because the verification of the acquired competencies of students is mainly carried out in the form of test tasks. Test tasks are designed to provide an opportunity to consolidate the material well and gain quality knowledge on each topic and cover all aspects of the theoretical material (Marhulov, 2021).

The need to use computer technology for automation of control, appropriate software causes systematic control of knowledge of a large number of students, and the use of computers for knowledge control ensures increased efficiency of the educational process and is economically beneficial. With their use, the quality of training is enhanced by synthesizing practice and science, and is not lost. For participants in the learning process, the learning process takes place in comfortable conditions, and the participants themselves become translators and carriers of knowledge during educational interaction (Hromovenko & Tytska, 2020).

The main components of the digitalization of educational institutions are:

- Electronic educational resources;
- Online education;
- Training using simulators;



- Electronic document management;
- Formation of competencies necessary in the digital world (Knysh et al., 2024).

The modern education system is experiencing a crisis of creativity. Classes increasingly discourage independent learning of new things by students, pay little attention to establishing an objective connection between the acquired knowledge and the surrounding real world, and to finding non-standard answers – use your imagination to standard questions, instead of using stereotypical models. Therefore, the educational institution of the future should become a place for the development of the human mind, and not just a place for the transfer of knowledge. Its main task is innovation and creativity, and not a mechanical response to tests or repetition of memorized facts. (Romashko, 2021).

Therefore, we believe that in modern conditions, the main vectors of education development are:

- Speed – the usual accumulation of knowledge has lost its relevance, and learning keeps pace with the times;
- Interdisciplinary content – combining knowledge from different spheres of life requires a direction that erases the rigid boundaries between education, business, production, and other spheres;
- The process of obtaining new knowledge simplifies the availability of materials in real time;
- Motivation and enthusiasm – fundamental principles in education, in which teachers, directing students in offline and online modes, become coordinators.

Therefore, within the framework of the trend of digitalization of education, a separate issue is the implementation of distance learning with new capabilities of digital technologies and on new principles (Mushenyk, 2022).

Analysis of the results of experimental work on assessing the effectiveness of the methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training.

The experimental study was conducted by a specially developed program based on the methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training. Based on the developed methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training, factors (dependent and independent variables) were identified that affect the state of consulting competence of future specialists (educational and methodological resources and conditions of professional training) and that change under this influence (motivational, cognitive components).

To prove the hypothesis of the study, we chose a parallel experiment. Therefore, the EG and CG of students were created. EG was influenced by the independent variable methodology. CG of students was not affected by this influence.

The experimental study program included the following actions: outlining the tasks of the experiment according to the specified goal; determination of the time and place of the experiment, its volume; characteristics of the groups and sample involved in the experiment; description of the methodology for experimenting; description of the materials for experimenting; characteristics of the variables influencing the results of the experiment; description of the interpretation and processing of the results of the experimental study.

The pedagogical experiment to verify the effectiveness of the developed methodology for the formation of consulting competence in the modern information educational space of future specialists was carried out in three stages: preparatory, practical, and final.

The preparatory stage of the study is aimed at performing the following tasks: analyzing the professional literature on the research problem; studying the experience of forming consulting competence in the modern information educational space of future specialists.

The practical stage of the study is aimed at implementing the following tasks: specifying the research hypothesis; developing and implementing a program based on the methodology for the formation of consulting competence in the modern information educational space of future specialists; ascertaining the state of consulting competence, and making control diagnostic sections. That is, the practical stage included three stages: ascertaining, formative, and control.

A formative experiment in the process of specially organized professional training of students was directly aimed at studying the phenomenon under study – the effectiveness of the methodology for forming consulting competence in the modern information educational space of future specialists.

The control experiment was conducted to compare the results obtained by students in the experimental group with the results obtained by students in the control group. The dynamics of the formation of consulting competence in the modern information educational space of future specialists in the process of professional training according to all specified criteria and levels were shown.

Before conducting the formative stage of the experiment, all participants and interested parties were familiarized with the ideas of the study. For this purpose, methodological recommendations were developed and implemented, which included: the idea, research hypothesis, definition of the research problem; creative tasks; methodological advice on the features of implementing the complex of tasks for forming consulting competence in the modern information educational space of future specialists; methodological advice on assessing the level of formation of consulting competence of future specialists.

At the final stage of the study, to increase informativeness, a discussion of the experimentally obtained data was conducted, the justification of the choice of methods for processing the obtained experimental results, the results of their processing and analysis, formulation of conclusions.

To verify the effectiveness of the proposed developed methodology for the formation of consulting competence in the modern information educational space of future specialists, selective observations were carried out to reveal the meaning of certain characteristics of the process and draw a conclusion based on the selective population (sample) from the general statistical (general).

Based on the generalization of a series of observations conducted in higher education institutions, the representativeness of the sample in the experimental and control groups of students was ensured.

Respondents who participated in the formative experiment were divided into 2 groups: experimental (EG) and control (CG). EG included 48 students, CG – 42 students. A representative sample was made up of parallel control groups and experimental groups in the study.

To find the most effective methods, means and forms of organizing the educational process, forming consulting competence in the modern information educational space of future specialists, educational monitoring was used, the purpose of which was to clarify the factors necessary for changing the situation, development, and not just tracking the state of a certain subject of educational activity. Educational monitoring was used according to two levels of functioning:

1. **Individual:** self-assessment by students of the quality of their consulting competence in the modern information educational space;
2. **Local:** assessment by a higher education institution of future specialists regarding the quality of their education, their achievement of the appropriate level of formation of consulting competence in the modern information educational space, according to certain indicators.

Methods of probability theory and mathematical statistics were used as the basis for processing the results of the experiment, in particular, the calculation of Student's t-criterion.

We were guided by the basic provisions when choosing diagnostic methods regarding reliability, validity, objectivity, and pedagogical measurements.

The implementation of these tasks is impossible without the development and application of the author's educational and methodological complex for the developed methodology for the formation of consulting competence in the modern information educational space of future specialists, to support the formation of consulting competence in the process of professional training. The content of the author's educational and methodological complex is focused on the features of the formation of consulting competence in the modern information educational space of future specialists; familiarizing students with the current problems of the current state of professional education; issues of organizing the educational process and its effective implementation in educational institutions during professional training; ways and types of using innovative educational technologies in the conditions of professional training of students.

In the conditions of higher education institutions, the subjects of management of the process of formation of consulting competence in the modern information educational space of future specialists are teachers of the cycle of disciplines of practical and professional training.

The ascertaining experiment, conducted through interviews with students, questionnaires, and statistical processing of the results, made it possible to state that at 97% level, the difference between the probability samples of the confidence interval, which were the control and experimental groups, is within 5% and is statistically insignificant, that is, the difference between the estimates of the levels of formation indicates an almost identical general level of formation of consulting competence in the modern information educational space of future specialists of the control and experimental groups (28% of respondents of the EG and 30% of respondents of the CG showed a low level of consulting competence, which made it possible to determine methods for increasing consulting competence in the modern information educational space of future specialists and to develop a methodology for the formation of consulting competence.

The results of the ascertaining experiment showed: there is mainly no interest in the formation of consulting competence, there is insufficient awareness of the need for management activities, in the context of the future profession there is no interest in studying the management component – in 30% of respondents in the control groups and 25% of respondents in the experimental groups.

Interest was shown in managerial activities, but only from the outside, because the respondents were dominated by external motives, 50% of future engineer-teachers in the control group and 57% of the experimental group.

A high desire to independently master managerial activities was characterized by 20% of respondents in the control group and 18% of respondents in the experimental group.

The results obtained indicate a low motivation of future specialists to form consulting competence. This explains the predominant focus on their own interests of future specialists. For respondents, education or professional activity is are only means of expressing their own "I". Such a focus has negative consequences: when solving professional problems, a tendency to make unconsidered and hasty statements in discussions; a desire to impose one's opinion on the team; a desire to always stand out, painful perception of criticism or remarks; adherence to a rigid algorithm of managerial actions, ignoring the needs of others; inability to cooperate or compromise in conflict situations, the predominance of motives for one's own well-being; a tendency to irritability, aggressiveness, and rivalry.

The formative experiment in the implementation of the methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional



training contributed to a qualitative change in the indicators of the phenomenon under study in the experimental groups.

Thus, compared with the data of the initial diagnostic section, the dynamics of motivation of respondents in the experimental groups are progressing in a positive direction.

In the experimental groups, the number of students who are aware of the need to form consulting competence and are distinguished by a stable interest in management activities increased by 17%. The respondents' orientation is oriented towards:

- Activity and its results, which affect the formation of consulting competence in the modern information educational space of future specialists;
- Interaction and communication.

Qualitative changes in the formation of consulting competence in the modern information educational space of future specialists have positive consequences in the process of professional training about professional activity: enthusiasm for mastering technologies and new skills; orientation to collective activity; ability to recognize and defend promising ideas in the interests of the cause and innovative proposals of employees, etc.

The number of students in experimental groups decreased by 12%, who do not show interest in the formation of consulting competence in the modern information educational space. Positive changes in the attitude of students to management activities indicate a positive dynamic of the formation of consulting competence in the modern information educational space in the process of professional training according to the motivational criterion.

The formation of consulting competence in the modern information educational space depends on the quality of theoretical knowledge, volume, and level of the managerial component of future professional activity.

The corresponding skills, abilities, and knowledge were characterized by the cognitive criterion of the formation of consulting competence in the modern information educational space in the process of professional and pedagogical activity.

During the ascertaining experiment, during the diagnostic section, 77% of the respondents of the control groups and 84% of the respondents of the experimental groups (most of the students) were at low and medium levels. Only 23% of the respondents of the control groups and 16% of the respondents of the experimental groups, according to the specified criterion, showed a high level of formation of consulting competence in the modern information educational space (Fig. 1).

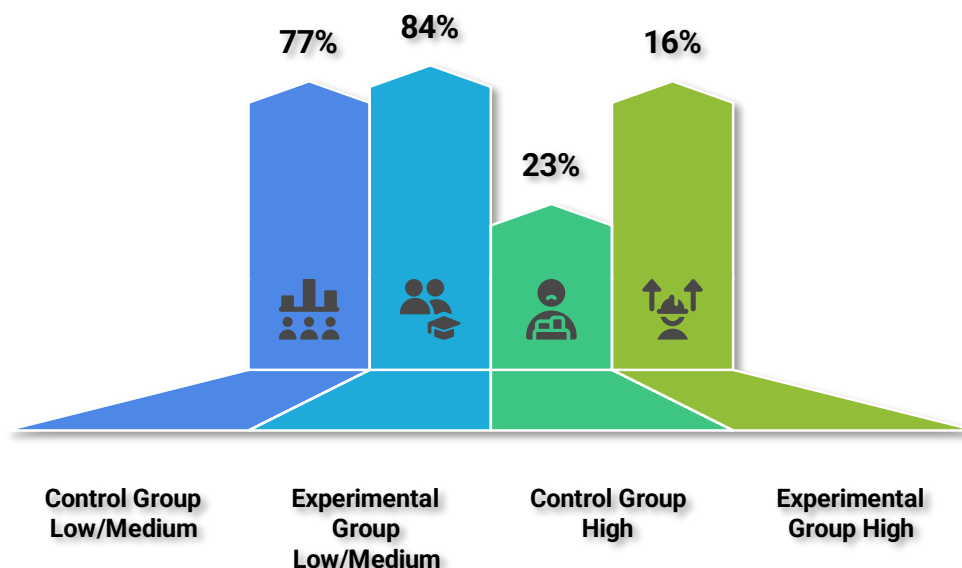


Fig. 1. Consulting Competence Levels in Educational Space.

Positive dynamics were observed after conducting a formative experiment in the experimental groups: the number of respondents who demonstrate a high level of assimilation, possession, and operation of consulting terminology, knowledge of the content and essence of future management activities in professional activities (management of education, training, development), as well as the innovativeness of methods, forms, and styles of management; the presence of a system of knowledge in management, knowledge about managing a professional process, and a team, has decreased by 15% (significantly increased). The number of students whose level of formation of consulting competence in the modern information educational space according to this criterion is characterized as low (by 7%) and average (by 9%). Positive changes also occurred in the control groups, but they are insignificant and did not affect the overall picture of the level of formation of consulting competence in the modern information educational space according to the cognitive criterion.

The rational choice of the sample size of respondents, the quality of which determines the correctness of the obtained data, ensured the reliability of the results of the experimental study.

Regarding the use of Student's t-test for analyzing ordinal data. While the consulting competence levels (low, medium, high) are ordinal, we treated them as quasi-interval based on the underlying scale construction and previous research in similar educational contexts. This approach is supported in educational psychology and pedagogical studies, where ordinal scales with sufficient gradation are often analyzed using parametric methods when assumptions of approximate normality and equal intervals are reasonably met.

The reliability of the differences and coincidences of the experimental and control groups was determined by calculating the t-criterion. Two hypotheses were formulated:

Hypothesis H0: the differences in the level of formation in the process of professional training of consulting competence in the modern information educational space of respondents in the control and experimental groups are not significant enough.

Hypothesis H1: the differences in the level of formation of the level of formation in the process of professional training of consulting competence in the modern information educational space of respondents in the control and experimental groups of students are quite significant.

Let us show the calculation of the dispersion of the level of formation of consulting competence in the modern information educational space of respondents.

The tabular value of the Student t-test – ($t_{tab.}(1.96)$ $t_{calc.}(0.18)$) – is greater than the calculated one. This indicates that the null hypothesis is not rejected, both samples belong to the same general population, that is, they are homogeneous for the level of reliability 0.05 (probability 5%), which allows us to speak about the insufficient significance of the difference in the level of preparedness of the control group and the experimental group of respondents and are conditionally equal.

The motivation of students in the experimental group after the experiment shifted towards an internal position, when the activity itself is important for the student. Thus, in the process of professional training, a high level of motivation formation to the level of formation of consulting competence of respondents in the EG increased in the modern information educational space by 17% compared to the CG, where the level increased by only 4%. Thus, the most significant qualitative changes at a high level of formation of the motivational component were confirmed by the analysis of experimental data.

The low level of formation of the motivational component also demonstrated positive qualitative changes: we observed a decrease in the number of students in the control group by 5% and in the experimental group by 12%.

At the average level, the smallest dynamics of qualitative changes in the level of formation of the motivational component were recorded: in the CG, 0%; in the EG, 5%.

In the control and experimental groups, a comparative analysis of the level of formation of the motivational component, in particular, the values of the average absolute value of qualitative changes, allowed us to conclude that the positive dynamics of qualitative changes is due in the CG to traditional professional training ($Avg = 4\%$), and in the EG – the result of professional training of students using the experimental method of forming consulting competence in the modern information educational space of future specialists in the process of professional training is significantly higher ($Avg = 14\%$).

Let us consider the results of the formation of the cognitive component.

Significant shifts were recorded in the experimental group by the end of the experiment. An increase in the high level of formation of the cognitive component is observed in EG students by 15%. In the CG, shifts in the opposite direction at this level occurred. The number of students with a high level of formation of the cognitive component decreased by 2%, which we explain by the decline in the motivational component of consulting competence, which is dependent on external factors of students' professional training. 7% of respondents (a significant number of students) EG – moved to the average level from low.

It should be noted that the analysis of experimental data showed qualitative changes, which are most significant, at a high level of formation of the cognitive component. During the pedagogical experiment, we observed an increase in the number of students by 15% in the EG. In the CG, the smallest dynamics of qualitative changes in the level of formation of the cognitive component were recorded in the category "low level" – 0.8%.

Comparative analysis of the level of formation of the cognitive component in the control and experimental groups, in particular, the values of the absolute average value of qualitative changes allowed us to state that in the CG the positive dynamics ($Av = 2\%$) of qualitative changes is due to traditional professional training, and in the EG – the result ($Av = 10\%$) of professional training of students using the experimental method of forming consulting competence in the modern information educational space.

The obtained experimental data on positive changes in the formation of consulting competence, its components in future specialists, give grounds to speak about the effectiveness of the experimental method in the process of professional training.

Analysis of experimental data at a low level showed qualitative changes in the formation of consulting competence of future specialists, which are due to the decrease in the number of students in the CG by 3% and in the EG by 9% during the pedagogical experiment for this category. Positive qualitative changes were demonstrated by a high level of formation of consulting competence: in the CG, there was an increase in the number of students by 2% and in the EG by 14% (Fig. 2).

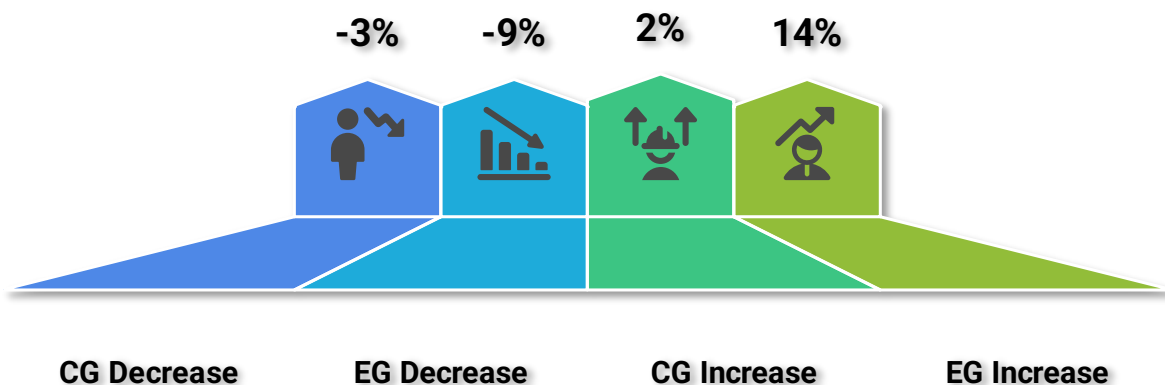


Fig. 2. Changes in Student Numbers During Experiment.

Comparative analysis in the experimental and control groups of the values of the average absolute value of qualitative changes in the level of formation of consulting competence made it possible to say that the positive dynamics of qualitative changes in the CG is due to traditional professional training – Avg = 2%, and in the EG – Avg = 10%) – the result of professional training of students using the experimental method of forming consulting competence in the modern information educational space of future specialists in the process of professional training.

Assumptions for the use of Student's t-test.

The use of Student's t-test in this study is based on the following statistical assumptions:

1. Normality of distribution:

The data in each group (experimental and control) have an approximately normal distribution. To test this assumption, the Shapiro–Wilk test was used, which is appropriate for small samples. Visual analysis was also performed using graphs that confirmed the approximate normality of the distribution.

2. Homogeneity of distribution:

The variances in the control and experimental groups are approximately the same. This assumption was tested using Levene's test for equality of variances. The results obtained showed that the assumption of homogeneity is not violated.

Both assumptions were tested before using the t-test. Since the conditions of normality and homogeneity were met, the use of parametric analysis (Student's t-test) is methodologically justified for comparing mean values between the control and experimental groups.

Empirical substantiation of the main hypothesis.

The main hypothesis of the study was that the use of the developed methodology contributes to a statistically significant increase in the level of formation of consulting competence in students of the experimental group compared to the control group.

To test the hypothesis, mathematical statistical methods were used. In particular, the Student's t-test for independent samples was used, which allowed comparing the average values of competence indicators between the experimental (EG) and control (CG) groups after the formative stage of the experiment.

The results of the statistical analysis showed:

The average value of the consulting competence index in the EG was $M = 3.87$, $SD = 0.62$, and in the CG, $M = 3.21$, $SD = 0.59$;

The calculated value of the t-test: $t(88) = 4.91$, $p < 0.001$;

The effect of the implemented methodology was calculated using Cohen's d effect measure, which was $d = 0.95$, which indicates a large practical effect according to generally accepted criteria.

In addition, the assumptions regarding the use of parametric tests were checked:

The normality of the distribution was confirmed by the results of the Shapiro–Wilk test ($p > 0.05$);

The homogeneity of variances was confirmed by the Levene test ($p > 0.05$).

Thus, the statistical analysis confirmed that the developed methodology has a statistically significant and practically important impact on the formation of students' consulting competence in the modern information educational environment.

Conclusions

Consulting activity is not only a functional management system, but is an independent branch of science and activity aimed at forming and ensuring the achievement of goals by any organizational structure through the rational use of material, labor, financial, and other resources. Consulting activity is a relatively new concept and is an independent branch of science and professional activity aimed at forming and ensuring the conditions for the development of a higher education institution.

Despite the significant achievements of various scientists, there is an objective need to improve the theoretical foundations of consulting in the field of informatization at the present stage, to substantiate strategic priorities, tactical mechanisms, and means of developing consulting services, and to reform the institutional environment of consulting support in the information space.

We have proven the effectiveness of the developed methodology for forming consulting competence in the modern information educational space of future specialists in the process of professional training.

The ascertaining experiment, conducted through interviews with students, questionnaires, and statistical processing of the results, made it possible to state that at the 97% level, the difference between the probability samples of the confidence interval, which were the control and experimental groups, is within 5% and is statistically insignificant, that is, the difference between the estimates of the levels of formation indicates an almost identical general level of formation of consulting competence in the modern information educational space of future specialists of the control and experimental groups (28% of respondents in the EG and 30% of respondents in the CG showed a low level of consulting competence, which made it possible to determine methods for increasing consulting competence in the modern information educational space of future specialists and to develop a methodology for the formation of consulting competence.

The formative experiment, when implementing the methodology for the formation of consulting competence in the modern information educational space of future specialists in the process of professional training,



contributed to a qualitative change in the indicators of the phenomenon under study in the experimental groups.

The experimental data obtained on positive shifts in the formation of consulting competence, its components in future specialists, give reason to speak about the effectiveness of the experimental methodology in the process of professional training.

Using the methods of mathematical statistics, the confirmed generalization of the results of the pedagogical experiment, in particular its formative stage, the calculation of Student's t-criterion, showed, in qualitative and quantitative indicators, significant differences in the levels of formation of consulting competence of future specialists in the process of professional training.

Research limitations.

The implementation of the pedagogical experiment was carried out in three stages during 2022-2024: preparatory, main, and final.

At the preparatory stage (2022), the goal and objectives of the study were determined, the experimental plan was developed, methods for measuring and processing the results were determined, the control and experimental groups were selected, and their homogeneity was checked.

At the main stage (2023), the experiment was conducted.

At the final stage (2024), the results of the experiment were analyzed, their reliability was confirmed, and conclusions were drawn about the pedagogical effect of the experiment.

Research relies heavily on the accuracy and reliability of data. The following digital data collection tools were useful in the study: MS Excel and SPSS (Statistical Package for Social Science) programs.

The total sample size in the article is 90 respondents. The sample of respondents was formed by random selection using the technical procedure for calculating the selection step.

During the experimental study, diagnostic data on the levels of social competence of higher education applicants were determined through informational influence and were divided into a control group (42 students) and an experimental group (48 students).

The limitations of this study allowed for the following impact on the results: improved quality characteristics of the material, optimally specified goals and objectives, and increased effectiveness of the results.

Future research directions.

Despite a significant amount of theoretical and applied research, a number of important scientific tasks remain unresolved. In particular, the typology of types of consulting project diagnostics needs to be developed, as well as the systematization of their influence factors.

The methodology for managing the diagnostics of consulting project implementation results and the model for economic evaluation of the implementation of diagnosed consulting projects require thorough improvement.

It is important to develop a graphical and analytical model for diagnosing the results of consulting projects for enterprises, which allows taking into account the interests of project participants in choosing diagnostic methods and techniques, as well as organizing monitoring of indicators and automated processing of diagnostic results to regulate deviations from the optimal values of the results of the diagnosed project.



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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.15>

Cómo citar:

Kachurynets, S., Yefimchuk, O., Fedorovska, I., Yunda, V., & Maidaniuk, I. (2025). Application of Methods for Developing Musical Hearing and Rhythm in Non-Music Students of Higher Education Institutions. *Revista Eduweb*, 19(2), 220-233. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.15>

Application of methods for developing musical hearing and rhythm in non-music students of higher education institutions

Aplicación de métodos para desarrollar la audición musical y el ritmo en estudiantes no musicales de centros de enseñanza superior

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Recibido: 30/04/25

Aceptado: 27/06/25

Abstract

The aim of this study was to determine the impact of musical exercises on the development of auditory and rhythmic skills in non-music students of HEIs. Testing of auditory skills, the method a comparative analysis for comparing the results of music-related and non-music students. A questionnaire survey for assessing students' attitude to the educational process through questionnaires and feedback. The results of the study confirmed that the previous musical training of students has a significant impact on the development of their auditory skills. Students in the control group (CG), who already had many years of experience in musical activity, presented high results in tests at the very beginning of the study. They showed a significant increase in indicators. In contrast, students in the experimental group (EG), who had no previous experience working with musical material, started from a lower level. Previous musical training plays an important role in the initial indicators of students' auditory skills. The test results confirmed that the EG



achieved the greatest success in the development of musical hearing. The academic novelty of the study is the adaptation of existing methods of developing musical hearing for non-music students of HEIs.

Keywords: Musical hearing development, development methods, types of musical hearing, non-music majors, pedagogy, higher education institutions.

Resumen

El objetivo de este estudio fue determinar el impacto de los ejercicios musicales en el desarrollo de las habilidades auditivas y rítmicas en estudiantes no musicales de IES. Prueba de las habilidades auditivas, el método un análisis comparativo para comparar los resultados de los estudiantes relacionados con la música y no relacionados con la música. Un cuestionario para evaluar la actitud de los estudiantes ante el proceso educativo mediante cuestionarios y comentarios. Los resultados del estudio confirmaron que la formación musical previa de los estudiantes tiene un impacto significativo en el desarrollo de sus habilidades auditivas. Los alumnos del grupo de control (GC), que ya contaban con muchos años de experiencia en la actividad musical, presentaron resultados elevados en las pruebas realizadas al inicio del estudio. Mostraron un aumento significativo de los indicadores. Por el contrario, los alumnos del grupo experimental (EG), que no tenían experiencia previa en el trabajo con material musical, partían de un nivel inferior. La formación musical previa desempeña un papel importante en los indicadores iniciales de las habilidades auditivas de los alumnos. Los resultados de las pruebas confirmaron que el GE logró el mayor éxito en el desarrollo de la audición musical. La novedad académica del estudio es la adaptación de los métodos existentes de desarrollo de la audición musical para estudiantes no musicales de IES.

Palabras clave: Desarrollo de la audición musical, métodos de desarrollo, tipos de audición musical, carreras no musicales, pedagogía, instituciones de enseñanza superior.

Introduction

Musical hearing is an important component of music education, which provides the basis for the development of students' musical abilities and competencies. When studying at HEIs, students of various majors, even if they do not have a musical education, often face the need to learn the elements of musical literacy, which is an important component of general culture. For such students, the development of musical hearing and rhythmic skills becomes not only a part of the educational process, but also an important condition for the development of their general cognitive and creative abilities.

The relevance of the study lies in the need to adapt the methods of developing musical hearing and rhythm in the context of non-music majors of HEIs to the peculiarities of the educational process, oriented to a wide range of students. Most current studies focus on the development of these skills in specialized musical institutions, but not enough attention is paid to methods that can be effective for students of non-music majors.

The aim of this research is to study and adapt methods for developing musical hearing in non-music students of HEIs. The aim involved the fulfilment of the following research objectives:

1. Analysis of the effectiveness of using various methods for developing musical hearing and rhythm in non-music students of HEIs.

The objective was to conduct a comparative analysis of traditional methods used to develop musical hearing and rhythm, as well as to determine their effectiveness in the context of students who do not have musical training.

2. Assessment of the level of musical hearing and rhythm in students before and after specialized classes.

The objective was to conduct an experiment where non-music students are divided into CG and EG. In the EG, regular classes aimed at the development of musical hearing and rhythm are held, after which the change in the level of these skills is assessed in comparison with the control data.

3. Study the changes in the level of students' confidence in auditory perception of musical elements (intervals, chords, rhythms, tempos) in the EG and CG after completing a course on the musical hearing development. To compare the effectiveness of the course in developing auditory confidence in students of different groups, to determine whether specific methods and approaches affect the level of confidence in auditory perception.

Literature Review

Digital technologies play a significant role in modern music pedagogy, helping to improve learning processes, in particular in aspects of the auditory skills development. In their study, Lu & Wang (2025) explored the impact of digital technologies on solfeggio and the pedagogy of ear and memory training. They noted that the introduction of digital tools into learning can significantly facilitate the development of musical skills, in particular in aspects of auditory memory and perception. Yan (2025) found that the integration of new technologies into the learning process can significantly improve the effectiveness of building musical skills, enabling students to work with virtual instruments, analyse musical compositions, and also train their hearing at a convenient time for them. Similar conclusions were reached by Pavlenko et al. (2024). In their study, Salim & Maulana, (2025) presented the development of an educational and training game aimed at increasing the sensitivity of hearing to musical intervals. The authors proposed an interactive approach to learning based on digital technologies, in particular, the creation of a game that enables students to train their hearing in a format that promotes greater involvement and effectiveness of learning.

Li (2024) examined the impact of listening to music on the level of students' musical literacy, in particular in the context of the use of modern online technologies for learning. The author compared the level of musical literacy of Chinese music-related and non-music students provided data indicating that the type of music that students listen to has a significant impact on the development of their musical skills, as well as on the overall level of musical literacy. The comparative analysis shows the difference in approaches to learning among students of different academic subjects and considers the role of online platforms in promoting the development of musical abilities through the latest technologies. Despite the relevance of the latest technologies for our education, Correia et al. (2022) analysed the possibilities of using digital technologies for assessing musical abilities. The results of the study showed that online assessments can be effective, but they need to be adapted and take into account a number of factors, such as acoustic conditions, platform interface and user capabilities.

In their work, Hou et al. (2024) considered the concept of bi-musicality, which combines the development of two important musical abilities: visual perception of notes and auditory perception of musical intervals, rhythms, and melodies. The authors proposed an approach in which visual and auditory training go in parallel, enabling students to develop both visual and auditory perception of music simultaneously. The researchers Balde et al. (2025) explored the relationship between musical expertise and auditory processing in a broader context. The authors focused on how the development of musical skills affects a person's ability to effectively process sound signals. The results of the study showed that musical experts have improved auditory processing abilities, which indicates a relationship between musical activity and cognitive processes of auditory perception. Stillie & Moir (2021) explored the importance of developing aural skills in the context of popular music. The authors emphasize that aural skills are one of the most important elements in music education, as they enable students to effectively recognize and interpret a variety of musical elements, such as intervals, rhythms, and chords. Their study emphasized the importance of integrating aural exercises with instruction in popular music classes, which helps students to develop both technical and creative skills.



In his study, Kimsanov (2024) considered the importance of developing students' musical abilities in children's music and art schools. The author focused on the methods and approaches used in educational institutions to develop students' auditory and performing skills. At the same time, the study of the beliefs of general education teachers and music specialists in Hungarian primary schools regarding the development of musical abilities in children conducted by Astalos (2023) found that general education teachers have a more limited understanding of the importance of music education and its impact on the students' overall development compared to music specialists. The study showed that the effective development of children's musical abilities requires supporting more interaction between general education teachers and music teachers, as well as conducting specialized trainings to raise the awareness of all teachers about the benefits of music education.

Methodology

Research design

The research design included several stages in order to systematically and consistently analyse the development of musical hearing and rhythm in students of non-music majors. At the preparatory stage, a content analysis of the methods for developing musical hearing and rhythm was conducted to systematize and evaluate the effectiveness of traditional and modern approaches. Three main methods were selected for the study: the Carl Orff method (1963), the Zoltán Kodály method (1974), and the Jacques-Dalcroze method (1921). Each of these methods contributed to the development of individual aspects of hearing, which enabled students to significantly improve their music perception skills.

The diagnostic stage involved initial testing of the participants' musical hearing and rhythm level to assess their initial skills. Test tasks were used, which included pitch determination, rhythmic exercises, and melodic repetition, to obtain initial data for further analysis of changes after the implementation of the methods. The experimental stage involved a total of twelve group musical and rhythmic trainings, which were held once a week for three months. The training programme was built on the synthesis of the three above-mentioned methods (Table 1).

Table 1.

Methods of developing musical hearing and characteristics of the exercises

Method	Type of hearing	Frequency of use	Exercises	Exercise duration
The Carl Orff, Zoltán Kodály, E. Jacques-Dalcroze methods	Melodic hearing	Once a week for 3 months	Recognizing notes, singing scales, performing simple melodies with gradual complexity, dictations, determining the pitch of notes, recognizing intervals.	20 minutes
The Carl Orff, Zoltán Kodály, E. Jacques-Dalcroze methods	Harmonic hearing	Once a week for 3 months	Recognizing harmonic consonances, singing chords, analysing harmonies, determining triads, harmonizing melodies.	20 minutes
The Carl Orff, Zoltán Kodály, E. Jacques-Dalcroze methods	Rhythmic hearing	Once a week for 3 months	Stepping to music, clapping rhythmic patterns, working with a metronome, reproducing rhythm according to a sample, reading rhythmic dictation.	15 minutes
The Carl Orff, Zoltán Kodály, E. Jacques-Dalcroze methods	Timbre hearing	Once a week for 3 months	Recognizing instrument timbres, comparing vocal timbres, electronic simulations of timbre changes, determining the instrumental composition of a work.	15 minutes
The Carl Orff, Zoltán Kodály, E. Jacques-Dalcroze methods	Pitch hearing	Once a week for 3 months	Singing chords, determining tonality, harmonic dictations, analysing folk music chords, harmonizing melodies.	20 minutes

Source: developed by the author.

The final stage involved testing to compare the level of musical skills before and after the experiment. Along with the testing, a questionnaire survey was conducted among students, consisting of 10 closed questions regarding the level of their musical training, ability to recognize rhythmic structures, difficulty in perceiving musical material, use of methods for developing musical hearing, and rhythm during learning, as well as their motivation to study musical subjects.

Research methods

To obtain relevant data, a set of methods was used that provide a comprehensive analysis of the effectiveness of the used approaches. Content analysis made it possible to study existing methods for the development of musical hearing and rhythm and identified the most effective approaches for their adaptation to non-music majors.

Testing was used to objectively measure the level of musical hearing and rhythm before and after the experiment, as quantitative data enable assessing the dynamics of skill development. It included tasks for pitch recognition, rhythmic exercises, and melodic repetition. The questionnaire survey supplemented quantitative indicators with qualitative analysis – it was aimed at studying students' attitudes towards musical exercises, their comfort when performing rhythmic tasks and self-assessment of auditory skills, which is important for assessing motivation and subjective perception of the educational process. Comparative analysis of testing was used to evaluate the effectiveness of the applied methods for the development of musical hearing and rhythm in music and non-music students.

Sample

The research sample was formed in such a way as to provide a wide range of data for the analysis of the development of musical hearing and rhythm among students of different academic fields. The selection of three HEIs from different regions of Ukraine allowed obtaining a representative sample of students studying in different programmes and in different conditions:

- 1) Educational and Research Institute of Arts of Luhansk Taras Shevchenko National University (Department of Musical Art and Choreography);
- 2) Khmelnytskyi Humanitarian-Pedagogical Academy (Faculty of the Humanities, Department of Vocal, Conducting and Choral Subjects);
- 3) The National University of Life and Environmental Sciences of Ukraine (Department of Culturology).

A total of 50 students were selected for the study from a total sample of 90 people. The selection was based on the principle of voluntary participation and compliance with previously defined criteria: the level of musical training, the presence or absence of formal musical education, as well as the willingness to complete the full course of the experiment. The participants were divided into two groups: the CG (25 students of music-related majors, mainly 2nd-year students) and the EG (25 students of non-music majors, 1st- and 2nd-year students). This division allowed for a comparison between those who already have basic musical knowledge and skills and those who study music as part of general education. The gender balance in the groups was close to equal, with a slight predominance of women (approximately 55%). Such a sample is critically important for assessing the impact of methods for developing musical hearing and rhythm, as it allows analysing the effectiveness of these methods among students without specialized musical training compared to those who already have certain skills in this area.

Instruments

Before starting the development of hearing in students of non-music majors, they were provided with the basics of musical literacy and the necessary materials for effective learning. The materials included recognizing notes on the staff, knowing the names of notes and their location on the staff. In addition, before starting the development of hearing, students had to acquire knowledge about the durations of notes



and pauses; basic musical sizes (4/4, 3/4, 2/4, etc.); alteration signs; the concepts of tone and semitone; degrees of scales; names, structure and types of intervals (prime (pure), second (minor, major), third (minor, major), fourth (pure), fifth (pure), sixth (minor, major), seventh (minor, major), octave (pure)); the structure of scales and their types (major (natural, harmonic, melodic), minor (natural, harmonic, melodic)); accents and dynamic changes; types of tempos; types of timbres and other basic musical notation. Special attention during the trainings was paid to consolidating theoretical knowledge and basic skills of musical literacy, which is necessary for the further development of hearing.

The research employed the methods of Carl Orff, Zoltán Kodály and Jacques-Dalcroze. SPSS and Google Forms were used to analyse the survey results, which allowed the systematization and statistical processing of the responses.

Results

Previous musical training plays a key role in the development of auditory skills, which confirms the results of the survey of students in both groups. The CG consisted mainly of participants who had experience in music education (Figure 1).

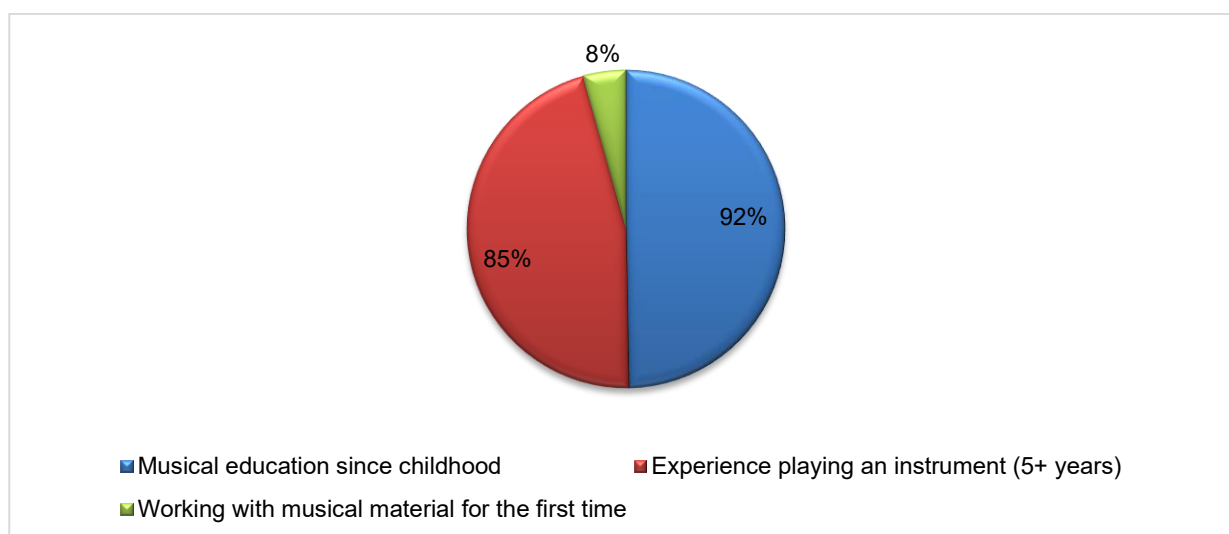


Figure 1. Musical experience before the start of the study of the CG students

Source: developed by the author

The CG consisted mainly of participants who had received musical education since childhood (92%) and had experience playing a musical instrument for more than 5 years (85%). Only 8% of respondents worked with musical material for the first time, which indicates a high level of preparation of the majority of participants. This was taken into account when analysing the results of the study, as previous musical experience could affect the development of auditory and rhythmic skills.

In contrast, the EG students in most cases worked with musical material in this format for the first time (Figure 2).

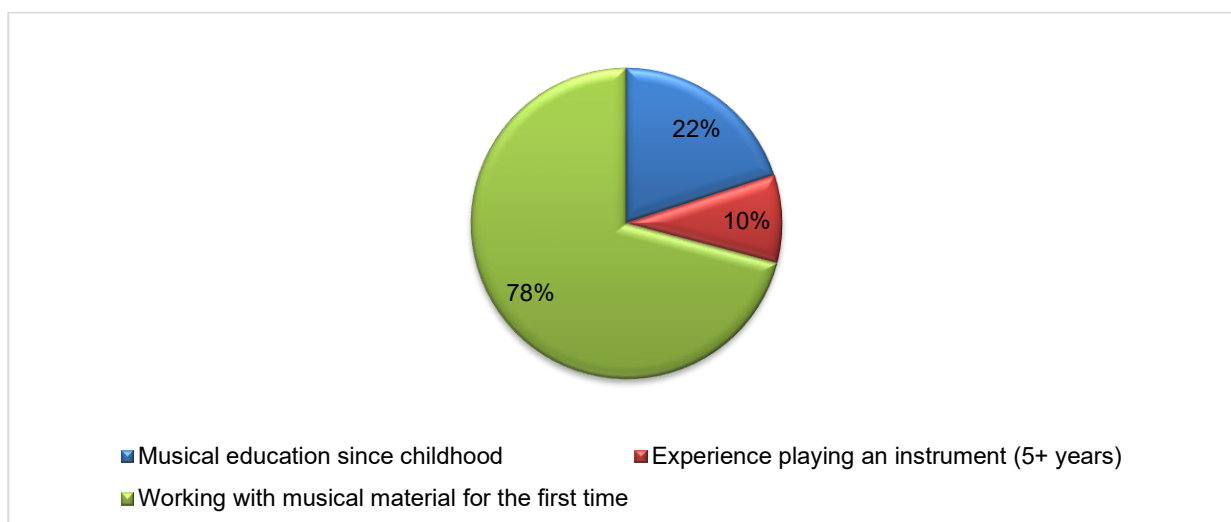


Figure 2. Musical experience of the EG students before the study

Source: developed by the author

The EG differed significantly from the CG in terms of their previous musical experience. Figure 2 shows that only 22% of participants had received musical education since childhood, and only 10% of respondents had more than 5 years of experience playing a musical instrument. In contrast, 78% of the EG students worked with musical material for the first time, which indicates a low level of previous musical training of the participants, which is an important factor in analysing the effectiveness of the applied methods for developing musical hearing and rhythm.

The influence of this factor was manifested in the initial testing results, where the CG had a significant advantage. However, the effectiveness of the applied teaching methods enabled students without previous experience to achieve significant progress, which confirms the plasticity of musical hearing and the possibility of its development regardless of the initial level.

Analysis of the dynamics of musical ear development among the EG and CG students revealed significant differences in the learning process and final results. It is expected that the CG music-related students (*Department of Musical Art and Choreography*) show significantly higher indicators in tests for melodic, harmonic, rhythmic and timbre hearing from the very beginning. However, the relative increase in skills among non-music students is of particular interest.

Statistical analysis showed that the average increase in scores in the CG was 5-10% from the initial level, while this indicator reached 15-20% in the EG. So, despite the lower final level, the non-music students showed greater efficiency in learning the material, which indicates high adaptability to new methods of developing musical hearing (Figure 3).

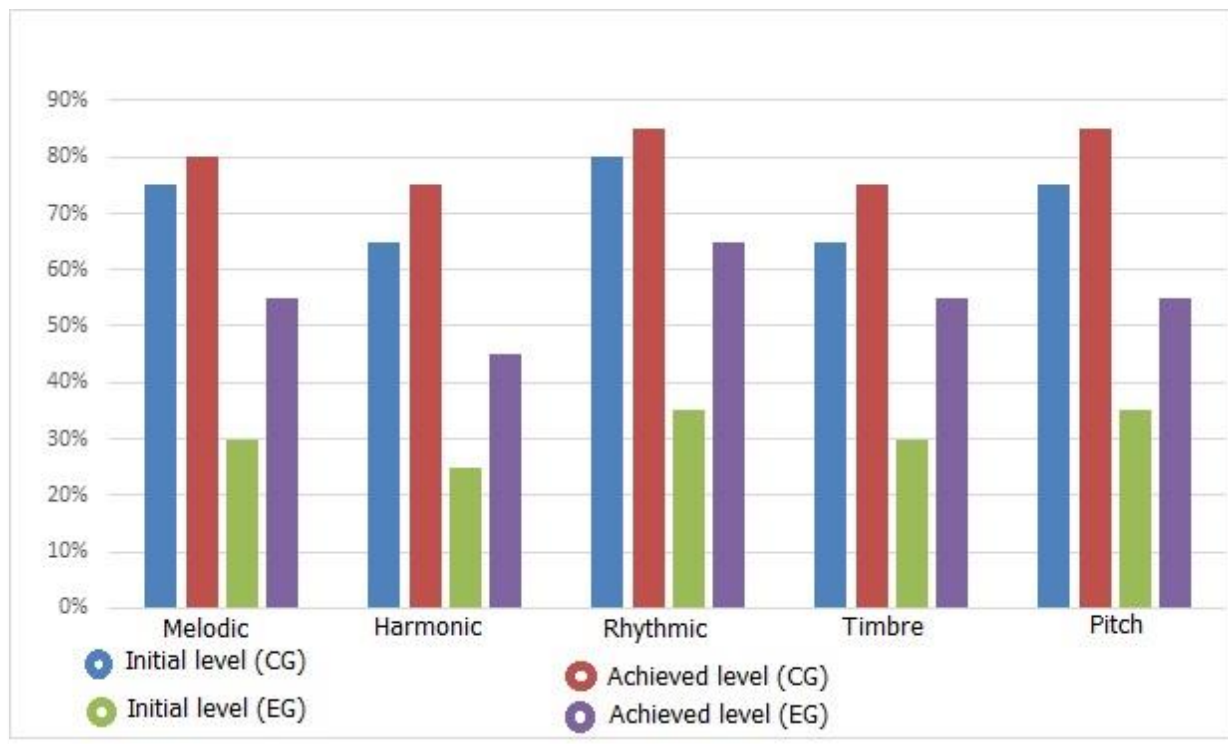


Figure 3. Results of testing before and after training in the CG and EG

Source: developed by the author

The development of musical hearing in students of the CG (music related majors) and EG (non-music majors) was studied in terms of melodic, harmonic, rhythmic, timbre, and pitch hearing. The improvement of melodic hearing in non-music students is accompanied by problems associated with insufficient differentiation of pitch relations. The indicators of melodic hearing in the CG increased from 75% to 80%, and in the EG — from 30% to 55%. The difference between the groups shows a different level of hearing development depending on previous training. The EG demonstrated high plasticity of auditory perception, but significant results require more repetitions and time to consolidate skills. The level of harmonic hearing in the CG increased from 65% to 75%, and in the non-music group — from 25% to 45%. Non-music students have difficulty recognizing complex harmonic structures because of lack of auditory experience. The development of rhythmic hearing in non-music students is complicated by the correct reproduction of complex rhythms. In the CG, the increase was 5% (80% → 85%), and in the EG — 30% (35% → 65%), which confirms the effectiveness of the methods. Timbre hearing in the CG improved from 65% to 75%, and in the non-specialist group — from 30% to 60%. Recognition of instrument timbres is difficult for non-music students because of their lack of experience. The level of pitch hearing in the CG increased from 75% to 85%, and in the EG — from 35% to 55%, which indicates the effectiveness of auditory exercises in non-music students.

The results of the survey of the EG and CG participants, which was conducted after the completion of the hearing development course, show a significant difference in the change in hearing skills between the groups (Table 2) (Table 3).

Table 2.
Results of the survey of the CG participants

Item No.	Question	Yes (%)	No (%)
1	Do you often have difficulty recognizing the pitch of notes?	55	45
2	Do you have difficulty distinguishing between different intervals in music?	20	80
3	Do you feel confident in your auditory perception?	70	30
4	Do you rate your ability to perceive melodies by ear as high?	60	40
5	Do you easily perceive complex musical intervals?	80	20
6	Can you easily determine the tempo of music?	65	35
7	Do you often have difficulty recognizing chords by ear?	30	70
8	Do you perceive music emotionally and with an understanding of structure?	60	40
9	Has your confidence in performing musical tasks increased?	85	15
10	Have you become more interested in studying music after this course?	60	40

Source: developed by the author

The analysis of the results of the CG survey shows that in general their ability to distinguish intervals, chords and pitch remains limited. Most participants note that they have difficulty distinguishing intervals, and they also encounter difficulties in identifying chords by ear. At the same time, although there is some confidence in their own auditory perception, the difficulty in perceiving complex musical elements, such as intervals and chords, remained unchanged after completing the course (according to the results of testing). Therefore, it can be stated that the classes held during the research did not lead to significant changes in the level of auditory skills of this group, and their difficulties remain relevant.

Table 3.
Results of the survey of the EG participants

Item No.	Question	Yes (%)	No (%)
1	Do you often have difficulty recognizing the pitch of notes?	65	35
2	Do you have difficulty distinguishing between different intervals in music?	70	30
3	Do you feel confident in your auditory perception?	50	50
4	Do you rate your ability to perceive melodies by ear as high?	40	60
5	Do you easily perceive complex musical intervals?	65	35
6	Can you easily determine the tempo of music?	65	35
7	Do you often have difficulty recognizing chords by ear?	60	40
8	Do you perceive music emotionally and with an understanding of structure?	65	35
9	Has your confidence in performing musical tasks increased?	85	15
10	Have you become more interested in studying music after this course?	90	20

Source: developed by the author

As for the EG, the results also present difficulties in recognizing the pitch of notes and intervals, but the difference is that these participants (according to the testing results) became more knowledgeable in the perception of musical components, in particular, in recognizing intervals and chords, as well as in the emotional perception of music. It is also important that a larger number (90%) of respondents noted an increased interest in studying music after the course, which evidences the training programme effectiveness.

According to the obtained data, the CG's level of interest in music after the course is 60%, while this figure reaches 90% in the EG. This difference in results indicates that the EG participants experienced a more significant increase in interest in music as a result of the course. It can be assumed that the specific techniques and exercises used in the EG helped to stimulate greater interest in musical learning and practice.

Regarding confidence in auditory perception, this figure in the CG is 70% after the course, and in the EG — 85%. A significant difference is also observed here, indicating greater progress of the EG participants in developing their auditory skills. This result may indicate a more effective application of the techniques and methods in the course aimed at improving auditory perception (Figure 4).

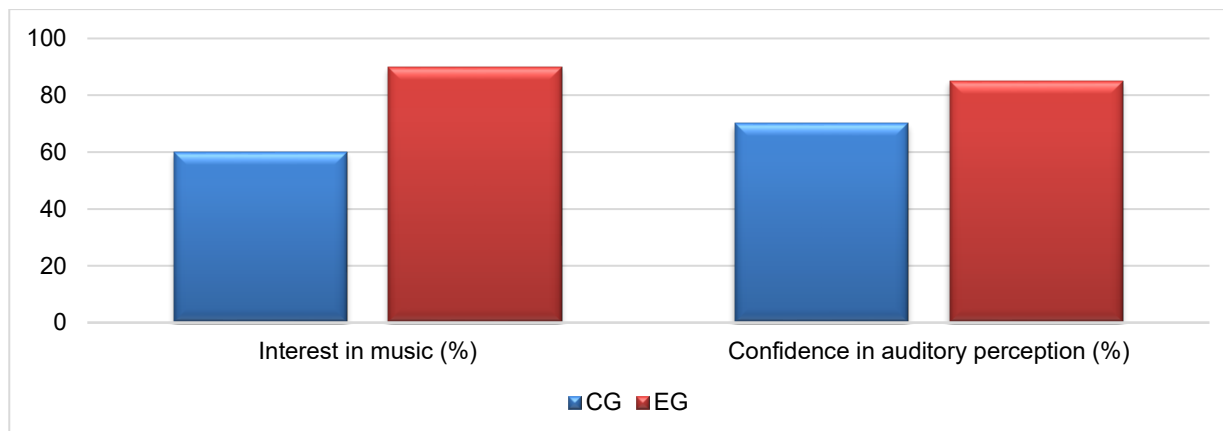


Figure 4. Comparison of the average level of confidence and interest in music in the CG and EG after the auditory skills development course

Source: developed by the author

A comparison between the two groups after the course shows that the EG participants achieved significantly better results in both the level of interest in music and confidence in auditory perception, which confirms that the specialized teaching methods used in the EG had a positive effect on the development of auditory skills and motivation to study music.

Such results can be explained by the inclusion of more intensive and adapted methods of developing musical hearing in the course for the EG, which enabled the participants not only to improve their auditory skills, but also to increase their confidence in their abilities. At the same time, the CG participants did not receive such a level of intensive training that could limit their progress.

Discussion

The effectiveness of the Kodály method in music education was studied by Kutlimuratovich (2024). The author noted that an important aspect of this approach is the integration of music education into the overall development of students' personalities, which allows for a deeper understanding of music through interaction with other types of art. Furthermore, the author concluded that the use of the Kodály method contributes to the creation of a positive atmosphere in music lessons, thereby helping students to develop both musical technique and self-expression. This study is consistent with the results of the application of the Kodály method for the development of musical hearing in non-music students.

The same conclusions were reached by Coughlan (2024). In their study, Tkatchova et al. (2023) analysed the influence of the methods of famous teachers on the development of music education in China. They examine how the creative achievements of Orff, Kodály, and Jacques-Dalcroze are integrated into Chinese pedagogical practice, particularly in the context of using these methods to develop children's musical abilities. The authors emphasized that these methods, despite their Western origin, are able to find application in the Chinese educational system due to their universality and emphasis on the creative development of the individual. They believed that Chinese teachers were able to achieve significant progress in music education through the use of musical games (Orff method), the development of auditory perception through singing (Kodály method), and motor practices (Jacques-Dalcroze method). Similarly, before the study of the development of musical hearing in non-music students, the authors concluded that

these methods contribute not only to the development of students' technical skills, but also to the development of their emotional sensitivity to music, helping to integrate art into everyday life and culture.

The methodology for developing musical hearing based on the Orff method was studied by Bigl (2022). The author focused on the fact that Orff created a learning system that includes various aspects – movement, singing, playing instruments – that helps students to better learn musical elements through active involvement. The article examines how the Orff method enables the creation of classes that are not only educational, but also highly interactive, where students can directly influence the learning process through playing in-class instruments. The author noted that children learn to listen to music as participants in the creative process in such conditions, which helps them to develop an inner sense of rhythm, harmony, and musical context. The Orff method is also relevant due to its music-based therapeutic elements. Senkal & Mukhtar (2021) concluded that the Orff method is an effective tool for improving auditory skills in children with intellectual disabilities, as it promotes the active involvement of children in the process, thereby helping them to develop not only auditory attention, but also other cognitive and emotional functions. This makes it easier for children to adapt to social situations and express their emotions through music, which is important for their overall development.

Zhang et al. (2024) reached the same conclusions. These studies are consistent with the results of adapting methods for developing musical hearing in non-music students. In his study, Colwell, (2022) investigated the experience of using the Orff method in music therapy among different groups of participants: students, clinicians, and teachers. The author noted that the Orff method has great potential for the development of music therapy and recommends its integration into curricula for students and clinicians. These results are comparable with research on the development of musical hearing in non-music students. Valasi (2023) studied the importance of rhythm as a key element in the Carl Orff method. The author emphasized that rhythm not only develops children's musical sensitivity, but also has an important role in the development of cognitive and social skills. All these studies emphasized the relevance and versatility of the Orff method, therefore, its use for the development of hearing in non-music students contributed to the acceleration of the process of improving various types of musical hearing, in particular: rhythmic, melodic, pitch, and timbre (Jones et al., 2013).

The Jacques-Dalcroze method was investigated in the study of Van der Merwe (2025). The author concluded that eurythmy, as a method, has the potential not only to develop physical and rhythmic skills, but also to improve the psycho-emotional state of the participants, making the process of learning music more joyful and satisfying. Elements of music therapy make this method relevant for teaching students who constantly face with stress because of learning and growing up. Iaddings (2024) studied the eurythmy of Dalcroze, its historical roots and development, as well as the possibilities of applying this method in choral programmes.

Apaydin (2023) explored the application of the Dalcroze method and rhythm in music education in Turkey. The author focused on the impact of this method on the development of musical skills of school and higher school students, emphasizing the importance of integrating movement and rhythm into learning. In his study, Daly (2022) concluded that eurythmy not only improves rhythmic perception and coordination, but also contributes to the development of personal autonomy in musical learning. This method allows students to actively engage in the musical process through movement, which helps to create unique, individualized forms of expression. Therefore, this study emphasizes the relevance of using the Jacques-Dalcroze method for the development of hearing in non-music students.

In his work, de Oliveira Honório (2023) examined the decision-making processes of undergraduate non-music students regarding the choice of classes in string instruments and orchestral subjects. The study emphasized that students are interested in developing personal skills, in particular creativity and teamwork, as well as the opportunity to gain new experiences, even if their studies are not directly related to music. Immerzeel et al. (2024) reached similar conclusions, but in addition to music, the author investigated sports and compared intrinsic and extrinsic types of motivation. Similarly, our study emphasizes the importance



of developing auditory skills and their impact on the overall learning process, especially among non-music students. Our study also emphasizes how developing musical hearing helps to improve the perception and performance of musical works, which, in turn, supports motivation to participate in music courses, even if their main studies are not directly related to music.

The importance of interpreting and studying musical settings in the context of music therapy and pedagogical training of students was emphasized by Sabadi, (2021). The author focused on the role of musical settings, which allow students not only to develop their musical skills, but also to become more aware of their own emotional experiences, which is an essential aspect in the pedagogical and therapeutic process. However, teaching music therapy to non-music students is impossible without a basic understanding of how music works. So, it is necessary to improve the students' auditory skills first. Therefore, the development of musical hearing and perception of music is important for non-music students, and especially for those who plan to obtain the music therapist skills.

Limitations

A limitation of the study was that the small sample size and short-term follow-up period did not allow for the assessment of long-term effects on musical hearing development. Moreover, individual differences among participants may create variation in the results, making their interpretation difficult.

Recommendations

Recommendations for further research include expanding the sample of participants to include students from different educational institutions, which would allow for more generalizable results. It is also worth conducting research over a longer period to assess the sustainability of the effects of musical hearing development. It is recommended to include additional assessment methods, such as interviews or surveys, for a deeper analysis of motivation and individual aspects of musical hearing development.

Conclusions

The study found that musical hearing development methods (Carl Orff, Zoltán Kodály and E. Jacques-Dalcroze) have a significant impact on students, even if they are not musicians by profession, which emphasizes the importance of including music education in general education. Even basic knowledge and skills in the field of music can have a positive impact on overall intellectual development, creativity and the ability to perceive and analyse complex sounds and sound structures.

The study showed the important role of prior musical training in the development of students' auditory skills. According to the results of testing and questionnaire surveys, the CG, which consisted mainly of participants with many years of experience playing musical instruments, had a significant advantage in the initial stages of the study compared to the EG, which indicates that prior musical training is an important factor in the speed of developing auditory skills. However, despite the initial difference in the level of training, the applied musical hearing development methods demonstrated high effectiveness in the EG students who had no prior experience of learning music. This result indicates a high potential for adaptation of auditory skills even in those students who start with minimal musical experience.

Analysis of the dynamics of changes in hearing indicators showed that non-music students, although they achieved a lower final level compared to the CG, had a greater increase in the development of auditory skills. The increase in test results in the CG was 5-10%, and in the EG — 15-20%. The obtained data indicate a greater effectiveness of the methods for non-music students, who showed high plasticity of auditory perception and the ability to assimilate the material, even when the initial level was low.

Despite the difficulties in recognizing complex harmonic structures and intervals, non-specialist students managed to achieve significant improvements through constant training, which confirms the plasticity of auditory skills even in the absence of previous musical experience. Tables and graphs of test and survey

results confirmed that, although the CG had higher initial indicators, the EG students managed to significantly improve their auditory skills thanks to specially designed techniques. In particular, a post-course survey showed that the EG students experienced a significant improvement in their ability to perceive and distinguish music by ear.

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.16>

Cómo citar:

Savitska, V., Matveieva, N., Chinchoy, A., Romanyshyna, N., & Sakh, Y. (2025). The effectiveness of multimedia boards/projection systems in teaching humanities. *Revista Eduweb*, 19(2), 234-251. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.16>

The effectiveness of multimedia boards/projection systems in teaching humanities

La eficacia de los sistemas de proyección/tableros multimedia en la enseñanza de las humanidades

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Recibido: 03/05/25

Aceptado: 27/06/25

Abstract

The relevance of the study is determined by the need to integrate digital technologies (multimedia boards/projection systems) into the training of specialists, in particular in the field of humanities, and the development of professional competencies through the use of modern multimedia tools. This study aims to assess the effectiveness of using multimedia whiteboards (MWBs) in building professional competencies among humanities students. The study employed methods of theoretical and methodological analysis, generalisation of studies, testing, questionnaire surveys, and work with interactive boards (including delimitation of space, selection of stickers, use of tags, and multimedia elements), among others. The study involved humanities students, particularly those majoring in Philology, Primary Education, and Pedagogy. The total number of participants was 300 students, who were divided into an experimental group (EG) of 150 students. And control (CG) of 150 students. All criteria underwent positive changes, especially in the aspects of practically-oriented skills (+30%), experience with information resources (+40%), and the level



of communication skills (+25%). At the control stage of the study, statistically significant differences were found between the EG and CG in terms of the level of professional competence ($\varphi_{crit} = 1.64 < \varphi_{emp} = 2.418$). The use of virtual boards significantly enhances students' competence, fostering active interaction and the solution of practical tasks. The questionnaire survey revealed that multimedia technologies increase involvement, enhance motivation and improve understanding of the material (average score 4.17–4.28). Their flexibility in learning was rated the highest (4.28), and their personalised features were rated the lowest (3.99). Overall, their use has a positive impact on the educational process. The academic novelty lies in the use of MWBs for developing competence in the current digital educational environment. Further research may focus on the effectiveness of interactive technologies in other humanities subjects and their impact on professional training. The study has a quasi-experimental design, which involves the participation of experimental and control groups without randomisation, but with precise control of variables and comparison of educational outcomes. This approach enables a reasonable assessment of the effectiveness of using multimedia boards and projection systems in developing students' professional competence. The theoretical contribution of the study lies in the development and testing of a pedagogical model for integrating digital tools into humanities education, covering the principles of visualising complex concepts, developing interdisciplinary thinking, active interaction in a digital environment, and individualising learning. The proposed approach can be adapted to other areas of education, taking into account the specifics of subject training.

Keywords: Digital technologies, humanities subjects, multimedia whiteboards, professional competence, projection systems.

Resumen

La relevancia del estudio se debe a la necesidad de integrar las tecnologías digitales (pizarras multimedia/sistemas de proyección) en la formación de especialistas, en particular en el ámbito de las humanidades, y en el desarrollo de competencias profesionales mediante el uso de herramientas multimedia modernas. El objetivo del estudio es evaluar la eficacia del uso de pizarras multimedia (PTM) para desarrollar las competencias profesionales de los estudiantes de humanidades. El estudio empleó métodos de análisis teórico y metodológico, generalización de estudios, pruebas, encuestas, trabajo con pizarras interactivas (incluyendo delimitación de espacio, selección de pegatinas, uso de etiquetas y elementos multimedia), etc. El estudio involucró a estudiantes de humanidades, en particular a los de Filología, Educación Primaria y Pedagogía. El número total de participantes fue de 300 estudiantes, que se dividieron en un grupo experimental (GE) de 150 estudiantes y un grupo de control (GC) de 150 estudiantes. Todos los criterios experimentaron cambios positivos, especialmente en los aspectos de habilidades prácticas (+30%), experiencia con recursos de información (+40%) y el nivel de habilidades comunicativas (+25%). En la fase de control del estudio, se encontraron diferencias estadísticamente significativas entre el GE y el GC en cuanto al nivel de competencia profesional ($\varphi_{crit}=1,64<\varphi_{emp}=2,418$). El uso de pizarras virtuales aumenta significativamente el nivel de competencia de los estudiantes, contribuyendo a la interacción activa y a la resolución de tareas prácticas. La encuesta reveló que las tecnologías multimedia aumentan la participación, mejoran la motivación y la comprensión del material (puntuación media: 4,17-4,28). Su flexibilidad en el aprendizaje obtuvo la máxima puntuación (4,28) y sus funciones de personalización, la mínima (3,99). En general, su uso tiene un impacto positivo en el proceso educativo. La novedad académica reside en el uso de pizarras virtuales para el desarrollo de competencias en el actual entorno educativo digital. Futuras investigaciones podrían centrarse en el estudio de la eficacia de las tecnologías interactivas en otras disciplinas de humanidades y su impacto en la formación profesional. The study has a quasi-experimental design, which involves the participation of experimental and control groups without randomisation, but with precise control of variables and comparison of educational outcomes. This approach enables a reasonable assessment of the effectiveness of using multimedia boards and projection systems in developing students' professional competence. The theoretical contribution of the study lies in the development and testing of a pedagogical model for integrating digital tools into humanities education, covering the principles of visualising complex concepts, developing interdisciplinary thinking, active interaction in a digital environment, and individualising learning.



The proposed approach can be adapted to other areas of education, taking into account the specifics of subject training.

Palabras clave: Asignaturas de humanidades, competencias profesionales, pizarras multimedia, sistemas de proyección, tecnologías digitales.

Introduction

Modern technologies are significantly transforming the education system, providing new opportunities for interactive learning (Gurevych et al., 2020). The use of MWBs and projection systems is becoming an essential element of the educational process, especially in teaching humanities (Frumkina et al., 2020). Research into the effectiveness of these technologies in developing students' professional competence is particularly relevant in the context of digital education and the need to enhance its quality (Vali, 2023). According to Filatova & Drobina (2021), interactive multimedia tools not only improve the assimilation of educational material but also contribute to the development of critical thinking, communication skills, and a practical approach to learning. As Kraus et al. (2022) note, digital transformation is significantly altering approaches to managing and organising educational processes, integrating technologies to enhance learning efficiency. Despite the active digitisation of the academic sphere, significant problems persist in the teaching of humanities disciplines, including insufficient interactivity in classes, limited use of multimedia tools, low student motivation to study abstract material, and a lack of individualised learning approaches. Most approaches remain focused on traditional teaching methods, which do not adequately meet the needs of the digital generation. At the same time, the literature only partially covers the specifics of implementing multimedia technologies in humanities education — research focuses mainly on STEM fields. Thus, there is a need not only to evaluate the effectiveness of such technologies empirically but also to develop a pedagogical model for their application in the formation of key professional competencies of humanities scholars.

The study aims to determine the effectiveness of using MWBs and projection systems in building the professional competence of humanities students.

The aim was achieved through the fulfilment of the following research objectives:

- Study the impact of multimedia technologies on the level of students' involvement, motivation, and understanding of educational material.
- Assess changes in the level of development of key students' competencies when using MWBs in the educational process.
- Determine statistically significant differences between the EG and CG in terms of the level of students' professional competence.

To provide a comprehensive understanding of the topic, Section 2 of this article presents an overview of scientific works devoted to digitalisation in education, with an emphasis on the application of multimedia technologies in teaching humanities disciplines. Section 3 provides a detailed description of the research methodology, including the quasi-experimental design, sample characteristics, data collection tools, and stages of the pedagogical experiment. Section 4 presents the results of the empirical study with an explanation of the quantitative indicators of changes in students' professional competencies. The discussion in Section 5 reveals the obtained data in the context of modern scientific approaches and compares them with the conclusions of other researchers. The article concludes with Section 6, which formulates the main findings, outlines the scientific novelty and practical significance of the obtained results, and proposes vectors for further research.

Literature Review

Research into digital technologies in teaching humanities is a promising but still underdeveloped field, especially in terms of the practical implementation of tools such as multimedia whiteboards (MWBs). Contemporary scientific literature generally attests to a positive attitude towards digitalisation. Still, it lacks depth in describing methodologies, application contexts, and quantitative measurement of effectiveness, which complicates the creation of an evidence base.

Thus, Killian & Floren (2020) argue that digital tools contribute to the development of intercultural competence. Their research is based on a survey of students in a multicultural environment; however, the authors do not specify the types of digital platforms or provide quantitative indicators of effectiveness. At the same time, Zhao et al. (2024), using a mixed-methodology approach that includes online surveys, semi-structured interviews, and classroom observations, demonstrate that interactive content improves student engagement. However, both studies acknowledge that digital technologies cannot completely replace traditional methods, especially in the humanities, where critical thinking and discussion play a leading role.

Khrystiuk & Tsymbal (2023), after analysing the educational strategies of Ukrainian higher education institutions, identified a lack of strategic integration of digital tools into humanities training programmes. Their research methodology included the analysis of official documents and surveys of teachers; however, its limitations included a small sample size (15 people) and a lack of empirical testing of the effectiveness of the technologies.

Ali (2022) study employed an experimental methodology, focusing on immersive technologies (AR/VR) in the study of complex concepts. The author noted an improvement in understanding of the material but acknowledged that such technologies require significant resources and are not scalable in regular educational settings, especially in the humanities.

Unlike technology enthusiasts, Baber (2020) emphasises the importance of preserving the interpersonal component in learning. A study based on a qualitative analysis of 40 interviews with teachers emphasises that technology should not negate the role of the teacher as a mentor. Anggraini & Handayani (2022) reach a similar conclusion after conducting a quantitative study of digital literacy among students ($n = 247$) and finding that humanities students have gaps in critical thinking in the digital environment. However, neither study considers practical tools such as MWBs.

Rajab (2018) analysed the use of online platforms in crises in seven countries. The author demonstrates that digital resources provide basic access to education but acknowledges limitations in the quality of student-teacher interaction. Similarly, Bakhmat et al. (2023) focus on economic specialities, analysing Moodle as an environment for developing digital competencies, without addressing the specifics of humanities education.

Devadze et al. (2022) outline global trends in the digital transformation of education; however, their work is primarily theoretical and does not provide empirical models for the humanities. Similarly, Krymets (2022) and Poperechna (2022) emphasise the changing role of teachers, but without analysing specific digital solutions and their impact on the development of key competencies.

Lund & Aagaard (2020) and Humeniuk & Romaniuk (2023) draw attention to the need to modernise teacher education, particularly in terms of improving cloud services. However, both works lack a focus on interactive tools (such as multimedia boards) and their effectiveness in a classroom setting.

Several authors explore interdisciplinary or STEM contexts that are only partially relevant to the humanities. In particular, O'Leary et al. (2020) analyse culturally sensitive teaching in STEM, Ritter (2022) analyses the use of digital games in primary school, and Santoveña-Casal & Fernández Pérez (2020) analyse pedagogical strategies in distance learning. They demonstrate the effectiveness of the multimedia approach but do not tailor their conclusions to the specific needs of teaching philology, history, pedagogy,

and related subjects. Finally, Tight (2022) and White et al. (2023) focus on the systematic implementation of digital solutions at the administrative level, but ignore the methodological aspects of their application in humanities classrooms.

In summary, it can be stated that:

Most studies focus on the general impact of digital technologies, without detailing specific tools such as MWBs.

There is a significant shortage of empirical studies in the humanities, particularly those employing quasi-experimental designs.

The sources reviewed lack a comparative analysis of the control and experimental groups, which is crucial for assessing effectiveness.

That is why there is a need for research that not only evaluates the effectiveness of multimedia boards in humanities education but also offers practical recommendations for integrating digital tools into the learning process, which is the purpose of this article.

Methodology

Research design

The main goal of the experiment was to test the didactic potential of MWBs/projection systems for building professional competencies in humanities students, particularly those majoring in Philology, Primary Education, and Pedagogy. The impact of MWBs and projection systems on students' educational results was also determined.

The preparatory stage of the experiment involved a general assessment of the existing level of theoretical knowledge, familiarity with terminology, skills in performing practically oriented tasks, experience in professional activity, and work with information resources.

The control measure provided for asking students to take tests on topics related to their future professional activities. The test questions were developed by the main criteria for the professional activity of a humanities specialist to determine: the level of theoretical knowledge, knowledge of terminology, the level of skills in solving practically-oriented tasks, experience in working with information resources, the consistency of logical thinking, analytical abilities, methodological competence, interdisciplinarity, and the level of communication skills. For each type of activity, five tasks were offered, resulting in a total of 45 tasks selected for testing. When analysing each criterion, the student received a "pass" rating if they scored three or more points. The testing structure is provided in Tables 1-9 below.

The Structure of Test Items

Table 1.

Level of theoretical knowledge

Item No.	Task
1	Identify the fundamental concepts of the humanities and their applications in professional settings.
2	Describe the key features of the development of the humanities in the context of current academic approaches.
3	Explain the basic methods of humanities research and their practical significance.
4	Determine the role and place of the humanities in shaping social values.
5	Analyse the interrelationship of the humanities and their impact on the educational sphere.

Table 2.
Knowledge of terminology

Item No.	Task
1	Define key terms in the humanities.
2	Distinguish between similar terms and explain their use.
3	Fill in the missing terms in the definitions of academic concepts.
4	State the correct meaning of a term in the context of a scientific text.
5	Choose the correct interpretation of terms from the provided options.

Table 3.
Practical problem-solving skills

Item No.	Task
1	Use humanitarian knowledge to solve a pedagogical problem.
2	Develop a concise teaching methodology that incorporates humanitarian approaches.
3	Suggest a solution to a problem situation in the field of intercultural communication.
4	Analyse the text for its compliance with the socio-cultural context.
5	Identify errors in the texts and suggest their correction based on humanitarian knowledge.

Table 4.
Experience working with information resources

Item No.	Task
1	Use electronic libraries to search for academic sources.
2	Determine the reliability of academic resources.
3	Analyse citations in academic publications.
4	Compare different methods of searching for information in humanities research.
5	Make a brief literature review on the chosen topic.

Table 5.
Sequence of logical thinking

Item No.	Task
1	Identify logical errors in a scientific text.
2	Build a logical chain of arguments in the study.
3	Analyse the text from the perspective of logical coherence.
4	Determine the sequence of presentation of material in an academic article.
5	Propose a logical scheme for solving a scientific problem.

Table 6.
Analytical skills

Item No.	Task
1	Analyse the text for the main idea and supporting arguments.
2	Identify the connection between different humanitarian concepts.
3	Compare various approaches to analysing cultural phenomena.
4	Identify problematic aspects in the proposed study.
5	Substantiate your point of view on the debatable issue.

Table 7.
Methodological competence

Item No.	Task
1	Create a lesson plan using an interdisciplinary approach.
2	Evaluate the effectiveness of different teaching methods in the humanities.
3	Develop exercises to consolidate theoretical material.
4	Analyse didactic materials for compliance with educational objectives.
5	Suggest strategies to enhance student motivation.

Table 8.
Interdisciplinarity

Item No.	Task
1	Determine the relationship between the humanities and natural sciences.
2	Analyse the use of humanities knowledge in technical fields.
3	Compare approaches to solving social problems across various scientific disciplines.
4	Propose an interdisciplinary approach to studying a specific phenomenon.
5	Determine the role of the humanities in modern society.

Table 9.
Communication skills

Item No.	Task
1	Analyse the features of academic writing.
2	Prepare a short report on a scientific topic.
3	Identify stylistic errors in the text.
4	Develop a presentation and explain its content to the audience.
5	Edit a scientific text according to language standards.

The general level of students' professional competence was determined by using the same test items. The student received a "pass" rating if they scored more than 27 points when completing all the tasks in the blocks. Otherwise, the student was considered to have failed the task. Fisher's angular transformation (Fisher's test) was used for statistical data processing.

At the next stage of the experiment, teachers conducted methodological work with the EG students on the possibilities of using virtual sticker boards to organise the study of educational material. Students were offered topics for joint work and individual tasks. The students' professional interests determined the formation of teams and the choice of topics. The indicative topics included: "The use of interactive methods in teaching humanities", "The application of a communicative approach in teaching", "Literary discourse: theoretical principles and practical aspects", etc.

Using virtual sticker boards, students formalised the results of their research and discussions, organised them by the logic of events, utilised graphic capabilities to build arguments, uploaded photos, videos, and audio files, and exchanged comments and tags. In experimental work, the possibility of practising practical skills of humanities students was realised through the use of MWBs and projection systems. Additional conditions for students' self-education were established, and a comprehensive presentation of educational materials was organised. In other words, systematic pedagogical work was carried out that meets the requirements of the digital society.

The CG students studied the topics Theoretical Principles of Text and Discourse, Pedagogical Methods of Teaching in Primary Education, as well as Psychological and Pedagogical Features of the Educational Process" by the work programme, using traditional lectures and seminars.

After integrating such interactive forms of work into the educational process, re-testing was conducted to assess the level of material mastery in the EG and CG. The questions for the test were developed according to the same principles as at the initial stage of the study.

The questionnaire survey was conducted at the end of the experiment in the EG. The primary purpose of the questionnaire survey was to gather students' perceptions of the impact of MWBs and projection systems on their educational outcomes. A scoring system was used to analyse the survey responses: strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5. The average score for each question was calculated by multiplying the number of responses in each category by its corresponding weight. The obtained values were then summed and divided by the total number of responses ($n = 150$). This approach enabled the collection of objective, quantitative data on the effectiveness of using MWBs and projection systems in teaching humanities.

Research methods

The research employed the following methods:

1. Experimental method — introducing MWBs and projection systems into the educational process of the EG of humanities students. The CG studied according to the traditional method. The comparison of the results from the two groups made it possible to determine the effectiveness of multimedia technologies in developing students' professional competencies.
2. A questionnaire survey was used to collect data on the subjective perceptions of students regarding the impact of multimedia technologies on their involvement, motivation, and success. The survey was conducted at the beginning and end of the experiment. Analysis of the responses made it possible to determine the dynamics of changes in students' attitudes towards the use of multimedia tools in education.
3. Testing: Students performed test items developed according to the criteria of professional activity for humanities students. The level of theoretical knowledge, knowledge of terminology, skills in solving practically oriented tasks, experience with information resources, consistency of logical thinking, analytical abilities, methodological competence, interdisciplinarity, and communication skills were assessed. The testing results allowed us to compare the level of competence before and after the experiment.
4. An observation method was used to analyse students' activity while working with MWBs, their interaction in the learning environment, and the level of participation in discussions and practical tasks. Observation made it possible to assess how multimedia technologies affect student interaction and their involvement in the learning process.

Sample

An empirical study was conducted at four higher education institutions (HEIs): Volodymyr Vynnychenko Central Ukrainian State University, Rivne State University for Humanities, Vasyl Stefanyk Precarpathian National University, and Bohdan Khmelnytsky National University of Cherkasy. The study involved humanities students, specifically those majoring in Philology, Primary Education, and Pedagogy. This approach contributed to the generalizability of the findings and provided the opportunity to compare the results in different academic contexts. During the experiment, data were collected from 300 students, who were divided into the EG (150 students) and the CG (150 students). The sample was random. The selected number of participants (300 students) was determined to ensure the representativeness of the sample and obtain statistically significant results. The students were divided into the EG and CG (150 students each) to determine the impact of multimedia technologies on the educational process. The number of participants in each group was sufficient to conduct a statistical analysis and test the significance of the changes obtained. The gender distribution (82% women and 18% men) aligns with the typical structure of humanities students, thereby increasing the ecological validity of the study. Ethical principles were observed at all stages of the study. The participants provided informed consent, while their anonymity and confidentiality were guaranteed at all stages of data collection and analysis.



Research instruments

The study employed a quasi-experimental design, comprising a control group (CG) and an experimental group (EG). Complete randomisation was not possible due to the existing structure of academic groups, which justifies classifying the study as quasi-experimental. Preliminary testing was conducted to verify the initial homogeneity of the sample. The results of Fisher's criterion ($\phi_{\text{emp}} = 0.098 < \phi_{\text{crit}} = 1.64$; $p > 0.05$) confirmed the absence of statistically significant differences between the CG and EG before the start of the experiment.

To control for the influence of external factors, both groups studied the same curriculum, had the same teachers, and were allocated the same number of academic hours, all of which were assessed according to the same criteria. The only variable was the use of multimedia boards and projection systems in the EG, which allowed for the isolation of an independent variable (technological intervention) and increased the reliability of the results.

The following tools were used in the study:

Software and interactive multimedia boards (IMBs) — EG utilised IMBs and the Linoit.com platform, which enabled students to collaborate on material in real-time, interacting through interactive stickers, marks, videos, hyperlinks, and other multimedia elements.

Questionnaire — the questionnaire consisted of 10 statements aimed at assessing the impact of MMD on motivation, engagement and understanding of the learning material. Responses were evaluated on a Likert scale (from 1 — 'strongly disagree' to 5 — 'strongly agree'). The content validity of the questionnaire was confirmed by three independent experts in the field of digital pedagogy. Reliability was assessed using Cronbach's α coefficient, which yielded a value of 0.87, indicating high internal consistency.

Testing before and after the experiment — the level of professional competence was assessed using a proprietary test consisting of 45 tasks covering nine criteria: theoretical knowledge, ability to use terminology, skills in solving practice-oriented tasks, logical thinking, analytical capabilities, methodological competence, information literacy, interdisciplinarity, and communication skills. The tasks were aligned with the educational objectives of the discipline. To increase objectivity, parallel forms of the test were used before and after the intervention.

Statistical analysis — Fisher's angular transformation (ϕ -criterion) was used to test the statistical significance of differences between groups, which is a relevant method for analysing proportional changes. The significance level was set at $p \leq 0.05$.

Thus, the use of a quasi-experimental design, valid and reliable instruments, and multi-stage measurement made it possible to reliably assess the causal impact of multimedia technologies on the formation of students' professional competence. The survey was conducted exclusively in the EG to avoid distortions in the assessment of students who had no experience working with MMD.

Results

The effectiveness of using multimedia technologies in the educational process was assessed through a comprehensive study of changes in students' professional competence levels. A repeated measurement was carried out at the stage of recording the experiment's results, which included 45 questions as the basis for analysing several criteria that determine professional competence. In particular, the level of theoretical knowledge, the ability to operate with terminology, skills in solving practically oriented tasks, experience in working with information resources, consistency of logical thinking, analytical capabilities, methodological competence, interdisciplinarity, and communication skills were assessed.

Based on these criteria, the CG and EG students were tested before and after the experiment. The testing results were used to evaluate the effectiveness of the applied learning approaches. All criteria underwent positive changes, especially in the aspects of practically-oriented skills (+30%), experience with information resources (+40%), and the level of communication skills (+25%). This confirms the effectiveness of the implemented teaching methods. The CG also had specific improvements, but they were less pronounced. The most minor changes are noticeable in the criteria of methodological competence, interdisciplinarity, and analytical skills (only +4-6%). In general, the obtained data demonstrate that the methods used in the EG significantly increased the level of students' training, especially in the practical aspects of professional activity. Detailed results are presented in Figures 1 and 2.

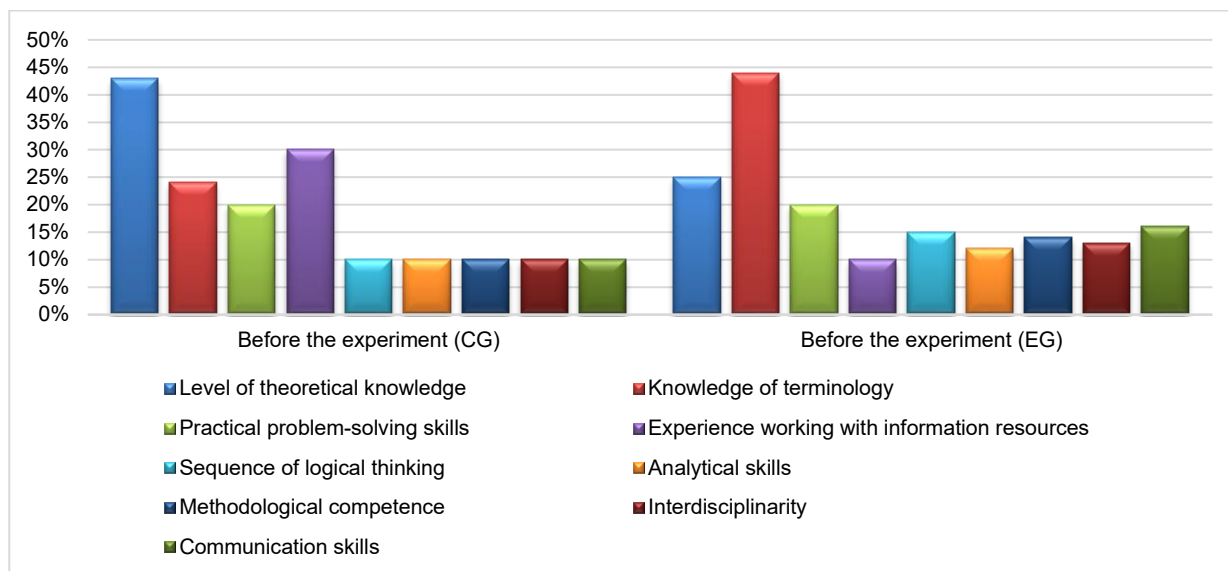


Figure 1. Assessment of the positive level of development of students' key competencies before the experiment.

Source: Developed by the author.

An analysis of the initial results for students in the control (CG) and experimental (EG) groups (Fig. 1) reveals noticeable differences in the level of development of specific key professional competencies, even before the start of pedagogical intervention. In particular, CG students had higher scores on the criteria of theoretical knowledge (43% in CG vs. 25% in EG) and experience with information resources (30% in CG vs. 10% in EG), indicating stronger analytical and theoretical foundations. At the same time, EG representatives demonstrated higher results in terms of knowledge of terminology (44% vs. 24%) and communication skills (16% vs. 10%), which may indicate a greater focus on interactive and practical components in their previous educational experience.

A preliminary analysis of the results also revealed that in both groups, the lowest scores were for methodological competence, analytical skills and interdisciplinarity (10–15%). These competencies belong to the higher cognitive level and are developed gradually, resulting in a minor increase in post-experimental testing, even with the active use of multimedia technologies.

To ensure the accuracy of the comparison of results between groups, homogeneity testing was performed using Fisher's criterion. The result $\phi_{emp} = 0.098$ at $\phi_{crit} = 1.64$, with a significance level of 0.05, confirms the statistical absence of significant differences between CG and EG before the start of the experiment. This allows us to discuss the initial equivalence of the samples and justify the reliability of the results obtained.

Thus, despite some natural fluctuations, the initial positions of students in CG and EG were sufficiently comparable to conduct a quasi-experimental study, the results of which allow us to judge the effectiveness of using interactive multimedia technologies in developing professional competencies.

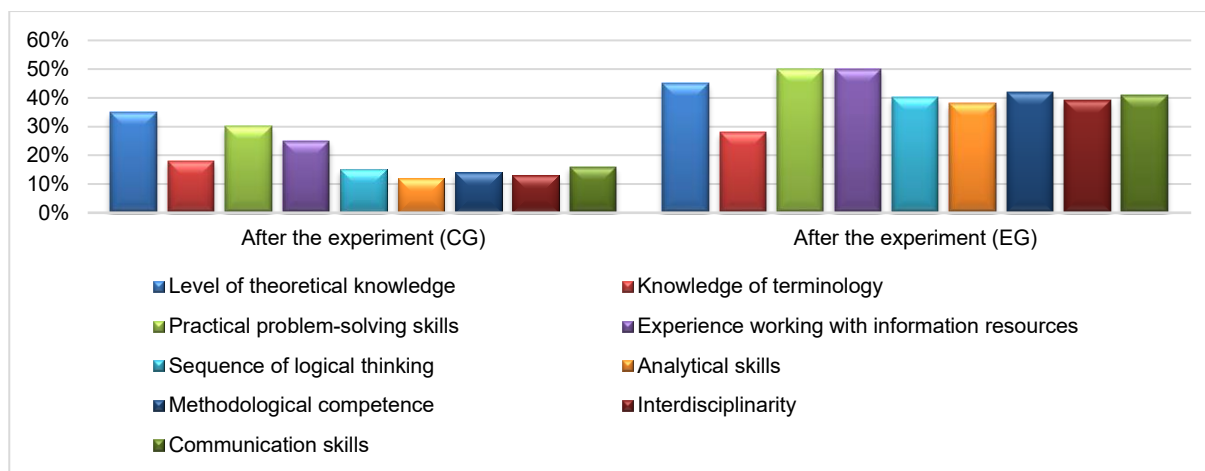


Figure 2. Assessment of the positive level of development of students' key competencies after the experiment.

Source: Developed by the author.

A comparative analysis of the results from the control (CG) and experimental (EG) groups, following the completion of the experiment, reveals a significant advantage for the EG in all criteria for assessing professional competencies. The most crucial progress is observed in the following competencies:

Practical problem-solving skills: 30% increase (from 20% to 50% in EG, compared to 30% in CG).

- Experience working with information resources: 40% increase (from 10% to 50% in EG, while in CG, only 25%).

Methodological competence: increased from 14% to 42% (+28%) in EG, compared to 14% in CG.

Analytical skills: growth from 12% to 38% (+26%) in EG.

Communication skills: 25% increase (from 16% to 41%), demonstrating the effectiveness of interactive methods.

These results confirm the hypothesis that the use of multimedia interactive whiteboards (MWBs) is particularly effective in developing applied and communicative skills, as opposed to purely theoretical knowledge.

In contrast, the smallest increase was observed in terms of 'knowledge of terminology' — only 4% (from 44% to 28% in the EG, compared to 18% in the CG). Several factors can explain this:

- High initial level in EG (44%), which limits growth potential under this criterion.

MWBs focus on visualisation and practical interaction rather than memorising terms.

The absence of specialised exercises in the programme specifically aimed at developing the vocal apparatus.

To verify the reliability of differences in competency progress between CG and EG, separate Fisher's exact tests were applied for each of the nine indicators. In all cases, the p value exceeded the critical value (1.64), which allows us to reject the null hypothesis of no statistically significant changes and confirm the effectiveness of implementing interactive technologies.

According to preliminary observations, MWBs are most effective in practical, interpersonal, and information-analytical areas that require visualisation, interactivity, adaptive tools, and rapid feedback — precisely the capabilities that MWBs provide.

Thus, the results confirm the conclusion that interactive technologies are disproportionately effective, with the most significant changes being achieved in applied competencies. At the same time, fundamental theoretical indicators remained stable or changed insignificantly.

Information on the overall test results (average percentage of the overall level of professional competence) before and after the experiment is presented in Table 10 and Figure 3.

Table 10.

Students' professional competence before and after the experiment

Item	Before the experiment		After the experiment	
	CG	EG	CG	EG
Students who failed the test	52% (78)	50% (75)	48% (72)	20% (30)
Students who passed the test	48% (72)	50% (75)	52% (78)	80% (120)

Source: Developed by the author.

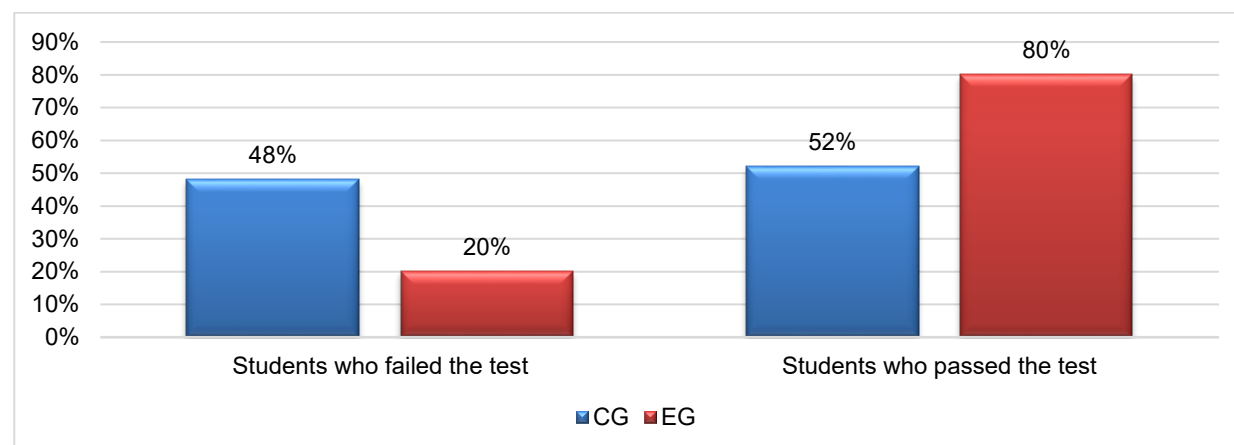


Figure 3. Results of testing students' professional competence after the experiment.

Source: Developed by the author.

The reliability of the results was checked using the Fisher test, which was performed using an online calculator.

The critical value of the Fisher test for a significance level of 0.05 (f_{crit}) is 1.64.

The following hypotheses were put forward:

- H_0 : the level of knowledge, skills and abilities that form the basis of professional competence of humanities students studying with the use of MWBs /projection systems (EG) is statistically no different from the level of students studying using traditional methods (CG).
- H_1 : The level of development of knowledge, skills, and abilities in the EG students is higher than in the CG.

The empirical value of Fisher's test before the experiment was 0.098 ($f_{emp} = 0.098 < f_{crit} = 1.64$). Therefore, the null hypothesis (H_0) is accepted at the initial stage.

After the experiment, the value of Fisher's test was 2.465 ($f_{emp} = 2.465 > f_{crit} = 1.64$), which indicates the rejection of the hypothesis H_0 and the confirmation of the alternative hypothesis H_1 .

Therefore, the differences in the levels of general, professional, and specialised competencies between the CG and EG students after the experiment are not accidental, but rather a natural consequence of the use of MWBs and projection systems in the educational process.

The survey on the impact of using MWBs and projection systems was conducted among EG students only, as they directly participated in the educational process using these technologies. Such tools were not used in the CG, which makes it inappropriate to survey their effectiveness on technologies with which they did not work.

Analysis of the results of the CG students' survey (Table 11) also indicates the high effectiveness of using MWBs and projection systems in teaching humanities. The highest average score was received for Question 10, which concerned the flexibility of using MWBs and projection systems, enabling work at an individual pace. The average score for this indicator was 4.28, confirming the significant positive impact of visual and interactive tools on students' interest.

Table 11.

Results of a study of the impact of using MWBs and projection systems in teaching humanities

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Average score
1. Using MWBs increases my involvement in discussions and active interaction during classes.	3	8	18	70	51	4.05
2. Interactive MWB opportunities improve my understanding of the learning material.	2	5	15	72	56	4.17
3. Using projection systems helps me perceive complex information more effectively through visualisation.	4	10	20	65	51	3.99
4. Interactive presentations and multimedia elements in classes enhance my learning motivation.	2	6	12	75	55	4.17
5. Sharing multimedia projects and assignments in classes helps me interact more actively with other students.	3	9	18	70	50	4.03
6. Access to recorded lectures using multimedia enables me to learn the material more effectively.	1	5	15	72	57	4.19
7. Using multimedia technologies makes lectures more interesting and exciting.	2	6	12	75	55	4.17
8. Personalised MWB functions (adaptive tasks, interactive exercises) meet my learning needs.	5	10	18	65	52	3.99
9. Using multimedia helps me to better prepare for independent work and tests.	3	7	15	70	55	4.11
10. Flexibility in the use of MWB and projection systems allows me to work at my own pace.	1	3	10	75	61	4.28

Source: Developed by the author

The lowest average score was recorded for Question 3, which assessed the ability of projection systems to facilitate better perception of complex information through visualisation. Despite this, the average score of 3.99 also indicates that students have a positive perception of the use of projection technologies in the learning process.

Other indicators also show high scores. For example, Questions 6 (4.19) and 7 (4.17) indicate that students highly value the ability to access recorded lectures and consider multimedia technologies to be a key factor in making the learning process more interesting. Overall, the obtained data confirm that MWBs and projection systems have a significant positive impact on the learning process, contributing to enhanced motivation, engagement, and increased quality of learning.

Discussion

The results obtained confirm several conclusions from previous studies regarding the positive impact of digital technologies on the quality of the educational process. According to Williams et al. (2023), the use of multimedia increases student engagement. In our study, this aspect is confirmed by high ratings in the questionnaire (average score 4.17–4.28), especially in terms of flexibility to work at one's own pace. The study by Gurantz et al. (2020) emphasises the link between interactive technologies and the growth of students' practical success, which is consistent with our result of a 30% increase in practical skills in the EG.

Khan et al. (2019) substantiate the effectiveness of interactive whiteboards in developing professional competence. Our study confirms this, as the communication skills of EG students increased by 25%. Hendawi & Nosair (2020) also point to the significant positive impact of MWBs on academic performance, which correlates with our indicator of improvement in information resource skills (+40%).

The theoretical value of these results can be viewed through the prism of J. Bruner's ideas (Bruner, 1966), who emphasised active student participation in the learning process, a constructivist approach to cognition, and the importance of creating 'learning situations' that stimulate thinking. The use of MWB creates an environment where students are not passive consumers of knowledge, but instead participate in the visualisation, analysis, discussion, and application of the material. This is consistent with Bruner's spiral learning concept, which posits that each new concept builds upon prior knowledge, allowing complex cognitive structures to be formed in a more convenient and accessible manner. The theoretical and methodological basis for understanding these results is expanded by the conclusions obtained in the works of Córdova Lapo & Lino Pérez (2024), which emphasise the role of interactivity as a key factor in actively engaging students in the learning process, particularly when using virtual whiteboards 2.0.

Arguello Mogrovejo & Vásquez Guerra (2023), summarising meta-analysis data, argue that the impact of digital technologies in the educational process depends not only on the type of tool but also on pedagogical design. In turn, Concha Abarca et al. (2023) emphasise the importance of digital tools for ensuring the inclusiveness and adaptability of the learning environment. Finally, Velasteguí López (2019) emphasises that digital whiteboards in higher education contribute to increased didactic effectiveness through visualisation, interactivity and personalisation of content. All these statements are consistent with the findings of our study, particularly regarding the high practical and communicative effectiveness of MWBs, as well as the need for clearer methodological design for the development of theoretical knowledge.

At the same time, specific results of our study indicate the need for a more critical analysis. For example, knowledge of terminology improved by only 4%, despite overall progress in most competencies. This may be due to the following factors: a high initial level for this criterion in the EG (44%), which limited growth potential; the indirect influence of multimedia boards on vocabulary formation; and the absence of targeted lexical tasks in the teaching materials.

This imbalance between applied and theoretical results allows us to draw an important conclusion: MWBs proved to be particularly effective for the development of practical, communicative, and information-



analytical competencies, while basic theoretical knowledge requires additional methodological approaches, possibly a traditional component or a hybrid model.

However, as noted by Alzubi (2023) and Wong et al. (2023), the effectiveness of multimedia tools largely depends on students' digital literacy. This may explain the lower scores on some parameters (for example, the use of personalised MWB features received only 3.99 points). Tang et al. (2023) and Zhylin et al. (2023) emphasise that the success of interactive technologies also depends on the level of teacher training — our results confirm this, as EG students demonstrated significantly higher results after the targeted use of multimedia in teaching.

It is worth noting the methodological limitations of the study:

Non-randomised nature of the sample: the formation of the CG and EG was not random, which potentially influenced the results.

Initial differences between groups: although Fisher's test did not reveal any statistically significant differences, graphical analysis (Fig. 1) shows differences in individual competencies prior to the experiment.

Possible measurement errors: the assessment tools used were based on questionnaires and tests without additional standardisation.

Lack of control over maturation effects: changes could have been caused not only by the influence of MWB, but also by the natural development of students during the semester.

Contextual factors, including differences between educational institutions, teaching styles, previous experience, as well as the level of digital culture and infrastructure, can significantly influence the perception and effectiveness of technologies.

Thus, although the study's results generally demonstrate the high effectiveness of interactive technologies in teaching humanities disciplines, their impact appears to be selective, with greater benefits for applied skills than for purely theoretical knowledge.

Therefore, interactive multimedia whiteboards (MWBs) are effective mainly for developing practical and communication skills. The formation of terminological and theoretical knowledge requires separate tools and cannot be based solely on visualisation. Teachers require specialised training to effectively integrate digital technologies into the learning process, taking into account the subject-specific aspects. It is essential to consider students' digital readiness when working with such tools.

Recommendations

The use of multimedia boards and projection systems is advisable to increase student engagement, improve understanding of the material, and visualise complex concepts. The effectiveness of learning increases due to interactive elements, personalised tasks, and access to recorded lectures. It is advisable to implement joint multimedia projects that enhance the development of communication skills and foster group interaction.

Conclusions

The study confirmed the positive impact of multimedia technologies on the development of students' professional competence, particularly in the development of practically oriented skills, the ability to work with information resources, and communication skills. All criteria demonstrated positive dynamics during the study, with particular increases in practically-oriented skills (by 30%), experience with information

resources (by 40%), and the level of communication skills (by 25%). A comparative analysis of the results of the CG and EG revealed statistically significant differences in the level of professional competence development ($\phi_{crit} = 1.64 < \phi_{emp} = 2.418$). The use of MWBs contributed to a considerable increase in students' competence, active involvement in the educational process, and effective completion of practical tasks. The survey confirmed that multimedia technologies have a positive effect on motivation, involvement and understanding of the material (average score 4.17–4.28). Their flexibility in learning received the highest score (4.28), while personalised features received the lowest score (3.99)

The study confirmed the positive impact of interactive multimedia technologies on the development of students' professional competence in the field of humanities education. At the same time, the results should be interpreted with consideration for the specifics of the research design. The quasi-experimental approach did not involve randomisation, which, to some extent, limits the possibilities for complete control over all external factors. It is also worth considering the possible influence of factors such as students' digital literacy, their previous experience, the specifics of teaching individual disciplines, and the educational context of the participating universities.

The results of the study are essential for teaching practice in higher education institutions, particularly those specialising in the humanities. They demonstrate the feasibility of integrating multimedia technologies into the process of developing applied, informational-analytical, and interpersonal competencies. At the same time, less pronounced improvement in the acquisition of terminological material indicates the need to combine interactive tools with methods aimed at systematic work with the conceptual apparatus.

The scientific novelty lies in the empirical substantiation of the specific impact of multimedia solutions on various components of students' professional competence. The practical value lies in identifying effective approaches to increasing engagement, motivation and learning effectiveness through visual and digital resources.

In further research, it is advisable to focus on several areas that will deepen our understanding of the effectiveness of interactive multimedia technologies in the educational process. Firstly, randomised experiments should be conducted, taking into account the control of maturation effects, which will ensure the higher reliability of conclusions and avoid distortion of results associated with the natural development of students during the learning period.

Further research may focus on assessing the long-term impact of interactive technologies in various fields of humanitarian education and their role in the training of specialists. Of particular interest is the study of the effects of students' digital literacy levels on the assimilation of various types of educational content, including theoretical, practical, glossary, and analytical content. This approach will enable digital tools to be more effectively tailored to the needs of specific audiences. Another promising area is analysing the effectiveness of combining interactive multimedia boards with other pedagogical strategies, such as gamification, project-based or blended learning, which could potentially increase student engagement and ensure comprehensive competence development. In addition, a relevant area of research is the comparison of the results of using multimedia technologies in different educational environments, including technical and humanitarian specialties, urban and rural institutions, with varying levels of material and technical support. Such an analysis will enable the formulation of differentiated educational strategies for implementing digital tools in the learning process.

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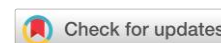


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.17>

Cómo citar:

Stepanenko, O., Stepanenko, A., Kostenko, S., Kolodin, D., & Chugunikov, I. (2025). Documentary analysis of Ukraine's educational policy in the context of conflict: the case of the ban on training lawyers in law enforcement agencies. *Revista Eduweb*, 19(2), 252-265. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.17>

Documentary analysis of Ukraine's educational policy in the context of conflict: the case of the ban on training lawyers in law enforcement agencies

Análisis documental de la política educativa de Ucrania en el contexto del conflicto: el caso de la prohibición de formar abogados en los organismos encargados de hacer cumplir la ley

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Recibido: 29/04/25

Aceptado: 18/06/25

Abstract

This article provides a documentary overview of the main regulatory and institutional changes that have characterised higher education policy in Ukraine in recent years, particularly in the context of the ongoing armed conflict and systemic reforms. Based on an analysis of laws, government decrees, strategic



documents and ministerial guidelines, the study identifies key priorities such as the digitisation of learning, strengthening university autonomy, internationalisation efforts, modernising education management and institutional resilience. Particular attention is paid to the ban on the training of lawyers in law enforcement and military higher education institutions, which is a typical example of the conceptual changes taking place in Ukrainian higher education. This political decision is seen in the context of efforts to harmonise legal education with European standards, increase academic transparency and consolidate legal training in civilian institutions. The aim of this article is to provide a thematic overview of recent policy changes from a normative and propositional perspective, without conducting an evaluative analysis of individual academic programmes or professional training outcomes. By focusing on both general trends and the specific case of legal education reform, the study contributes to a better understanding of how conflicting transformations intersect with long-term policy goals in Ukraine's higher education system.

Keywords: higher education in Ukraine, educational policy, legal education, higher education reform, academic independence, educational standards.

Resumen

Este artículo ofrece un panorama documental de los principales cambios regulatorios e institucionales que han caracterizado la política de educación superior en Ucrania en los últimos años, particularmente en el contexto del conflicto armado en curso y las reformas sistémicas. Basándose en un análisis de leyes, decretos gubernamentales, documentos estratégicos y directrices ministeriales, el estudio identifica prioridades clave como la digitalización del aprendizaje, el fortalecimiento de la autonomía universitaria, los esfuerzos de internacionalización, la modernización de la gestión educativa y la resiliencia institucional. Se presta especial atención a la prohibición de la formación de abogados en instituciones de educación superior policiales y militares, que es un ejemplo típico de los cambios conceptuales que están teniendo lugar en la educación superior ucraniana. Esta decisión política se considera en el contexto de los esfuerzos para armonizar la educación jurídica con los estándares europeos, aumentar la transparencia académica y consolidar la formación jurídica en instituciones civiles. El objetivo de este artículo es proporcionar un panorama temático de los cambios recientes en las políticas desde una perspectiva normativa y propositiva, sin realizar un análisis evaluativo de los programas académicos individuales o los resultados de la formación profesional. Al centrarse tanto en las tendencias generales como en el caso específico de la reforma de la educación jurídica, el estudio contribuye a una mejor comprensión de cómo las transformaciones conflictivas se cruzan con los objetivos de políticas a largo plazo en el sistema de educación superior de Ucrania.

Palabras clave: educación superior en Ucrania, política educativa, educación jurídica, reforma de la educación superior, independencia académica, estándares educativos.

Introduction

Reforming legal education in Ukraine is a complex and multifaceted process that is actively developing in the context of European integration and bringing the higher education system into line with European standards. Particular attention in this process is drawn to the issue of banning the training of lawyers in institutions of law enforcement agencies, such as the Ministry of Internal Affairs (hereinafter - the Ministry of Internal Affairs), the Security Service of Ukraine (hereinafter - the SBU) and military higher educational institutions. This ban is related to the need to unify legal education, ensure academic independence and adapt educational programs to international and European standards (Law of Ukraine No. 1556-VII, 2014; Verkhovna Rada of Ukraine, 2024; Verkhovna Rada of Ukraine, 2020).

The ban on training lawyers in law enforcement universities poses a number of challenges, including adapting the education system to new regulatory requirements, in particular, improving the quality of legal training, its compliance with international standards, and eliminating conflicts between the institutional specifics of law enforcement universities and the principles of academic education (Buhaichuk, 2022; Abroskin & Albul, 2021). The assessment of the state of reforms is confirmed by the official report of the



European Commission on Ukraine (European Commission, 2023), which emphasizes the critical importance of guaranteeing academic independence and integrating the education system into the European higher education space.

Over the past decade, legal education in Ukraine has undergone numerous transformations, reflected both in legislative acts (Ministry of Internal Affairs of Ukraine, 2008; Order of the Ministry of Education and Science of Ukraine (Order No. 673, 2020) and in conceptual documents (Verkhovna Rada of Ukraine, 2020). At the same time, current research shows insufficient attention to the systematic analysis of the conflict between the special conditions of training in law enforcement agencies and the general requirements for legal education (Molchanov, 2021; Shemelynets, 2024).

Insufficient integration of law enforcement institutions into the national legal education system may lead to a shortage of highly qualified lawyers in law enforcement agencies and complicate the process of their professional integration into the labor market (Fact News, 2025). At the same time, in conditions of martial law and increased requirements for national security, the problem of improving legal training in law enforcement agencies becomes particularly urgent (Resolution No. 295, 2022).

Thus, the topic of the study is extremely relevant and requires a comprehensive analysis of regulatory and legal changes, European education standards and their impact on the system of training lawyers in the institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military universities. The results of this study will have practical significance for improving higher education policy in Ukraine and will contribute to ensuring effective legal education that meets the challenges of the time and international requirements.

The object of the study is the policy of higher education in Ukraine in the field of training lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine, and military higher educational institutions.

The subject of the study is conceptual shifts and regulatory changes related to the ban on training lawyers in these institutions, as well as their impact on the legal education system and professional training.

The research objectives of the study are:

To analyze the regulatory framework that regulates the training of lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine, and military educational institutions.

To identify the main conceptual changes in higher education policy that led to the ban on training lawyers in these institutions.

To consider the prospects for the development of the legal education system in the context of Ukraine's European integration requirements and to offer recommendations for improving educational policy in this area.

Theoretical Framework and Literature Review

During the research of conceptual shifts in the policy of higher education in Ukraine regarding the ban on training lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military universities, the works of Ukrainian and foreign scholars were studied and analyzed. Despite the existence of individual studies, the topic of conceptual shifts in the policy of higher legal education in Ukraine - in particular in the context of the ban on training lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military universities - remains insufficiently covered and requires detailed scientific understanding.



At the same time, in the context of the topic under study, it is important to refer to the existing scientific discourse, which, although limited in scope, and approaches to assessing legal education in the context of reforms, are worthy of attention.

One of the most conceptually rich sources is the analytical work of Posylnyi (2024), in which the author clearly emphasizes the need to bring legal education in Ukraine into line with European Union standards. The author emphasizes that training lawyers in institutions with special training conditions (such as the Ministry of Internal Affairs, the Security Service of Ukraine, and military academies) contradicts the principles of academic freedom, independence, and transparency, which are fundamental to the legal profession in democratic legal systems. This approach is fully consistent with the European vision of legal education as a sphere free from political or administrative influence. We share Posylnyi's view that systemic reform is impossible without demonopolizing the right to legal training, as well as without creating equal conditions for all higher education institutions.

At the same time, Buhaichuk (2022) demonstrates a different approach in his publication, defending the right of departmental universities (in particular, the Ministry of Internal Affairs system) to train lawyers. The author argues this with the functional needs of internal affairs and the specifics of the service. Such a position, although it has a certain logic in the context of professional adaptation of personnel, does not take into account the global trend towards the unification of legal training for the civilian market and the need for a clear distinction between academic education and professional in-service training. We believe that such reasoning is insufficient to maintain the status of legal training in the institutions of the Ministry of Internal Affairs as equivalent to academic.

Similar views on the gradual adaptation of the MIA institutions to the new requirements are also expressed by Abroskin & Albul (2021), who consider the transformation of higher legal education as gradual and organic. The authors try to integrate departmental HEIs into the framework of the Concept for the Development of Legal Education. However, we do not share the authors' optimism about the possibility of a full-fledged reform of legal education within structures subordinate to law enforcement agencies. Such subordination contradicts the basic principles of the legal profession, which should be based on independence of thinking and the absence of institutional pressure.

A more pragmatic, but still optimistic position is taken by Molchanov (2021), considering the prospects for the "efficiency" of the Higher Education Institutions of the Ministry of Internal Affairs after the implementation of the concept of the development of legal education. However, efficiency, in the author's understanding, is interpreted more as administrative functionality, rather than academic quality or compliance with international standards. According to the scientist, it is possible to increase the efficiency of the Higher Education Institutions of the Ministry of Internal Affairs after the implementation of the reform, but he does not provide a clear analysis of how these institutions can achieve academic independence or ensure quality comparable to leading law schools.

At the same time, Shemelynets (2023) draws attention to the problem of the contractual form of training in the MIA Higher Education Institutions, which is used not to train system personnel, but to allow graduates to enter the general market of legal services. This creates a distortion of competition, where students receive a law degree without guarantees of academic freedom and without compliance with uniform educational standards. The author analyzes the tendency to train "contract workers" in MIA higher education institutions, who subsequently work in the civilian sector. The author questions the effectiveness of such a model. We fully support the critical approach to the actual "export" of personnel from departmental higher education institutions to the general legal market. In our deep conviction, this distorts the logic of the distribution of legal personnel and market competition. In another study by Shemelynets (2024) on the compliance of legal training in departmental HEIs with European integration standards, the author provides empirical evidence of non-compliance with standards of transparency, quality, and independence of the educational process in the relevant institutions, which confirms the need for their transformation or complete abandonment of legal programs in such institutions.

Special attention is also paid to the analytical work of Hryshchenko et al. (2021), which examines the professional training of lawyers, its international models and the shortcomings of the national system. The authors justify the need for the unification of educational programs, the introduction of transparent assessment mechanisms and the autonomy of the educational process. Their position is close to the European model, which excludes the possibility of hybrid legal education under institutional control by law enforcement agencies.

An analysis of the contemporary academic and analytical discourse on the reform of legal education in Ukraine, particularly in terms of the functioning of educational programs in departmental institutions, demonstrates the presence of several key conceptual approaches. They differ significantly in their methodological basis, institutional guidelines, and value coordinates.

The first group consists of studies that consistently substantiate the incompatibility of the model of training lawyers in institutions with special training conditions with modern European educational standards. Such works include the studies of Posylnyi (2024), Shemelynets (2023, 2024), etc. The main theses of these authors boil down to the fact that legal education by its very nature requires adherence to the principles of academic freedom, open access, independence of the teaching staff and student self-government - principles that cannot be implemented in the conditions of hierarchical and power-based institutions. Such institutions, being integrated into the system of power structures, by their nature determine the official dependence of the educational process on political, departmental or corporate expediency, which directly contradicts the essence of the legal profession in a democratic society. The position of this group is reasoned, conceptually balanced and consistent with international recommendations. It forms a systemic critical platform to justify the complete abandonment of the practice of training lawyers in departmental educational institutions.

The second group of works (Buhaichuk, 2022; Abroskin & Albul, 2021; Molchanov, 2021) represents a pragmatic, technocratic approach that focuses on improving the existing system without radically revising its legitimacy. Within this approach, the institutions of the Ministry of Internal Affairs system are considered as a necessary tool for ensuring the industry's needs for lawyers with specific training, and legal education is considered as a means of forming a "loyal", institutionally adapted specialist. The authors of these works emphasize the modernization of programs, the integration of modern teaching methods, and the development of the internal quality of the educational process, without touching on the problems of autonomy, impartiality, or openness. This approach has limited heuristic value, as it does not offer a conceptual solution to the conflict between departmental interests and the public nature of the legal profession. In addition, it often ignores the challenges associated with the opacity of access to the profession, institutional closure, and insufficient compliance with European criteria for legal education.

To summarize, we can draw the following conclusions:

The current model of training lawyers in the institutions of the Ministry of Internal Affairs, the Security Service of Ukraine, and military academies is incompatible with the principles of democratic legal education, in particular in terms of independence, ethical autonomy, social responsibility, and interdisciplinary application of legal knowledge.

Technocratic approaches to modernizing departmental legal programs do not resolve conceptual contradictions, as they leave aside the fundamental question of whether these institutions should train lawyers at all, or whether their function should be limited to in-service training within their competence.

The commercialization of educational services in departmental universities further deepens the structural crisis of legal education, creating shadow mechanisms for access to the profession and undermining public trust in the legal training system.



In light of Ukraine's European integration commitments, as well as in view of the recommendations of the European Commission and the Venice Commission, the ban on training lawyers in law enforcement and military higher education institutions is seen as an inevitable and justified step that will create institutional conditions for the formation of an independent, ethically responsible and competitive legal community.

Thus, the further transformation of legal education should be based on a fundamental distinction between specialized in-service training and academic legal education, with a clear priority for the latter as a universal path to the legal profession in a democratic state governed by the rule of law.

Methodology

The methodological basis for studying the problem of banning the training of lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military higher educational institutions was formed on the basis of the complex application of a number of scientific methods, each of which provided a deep and comprehensive analysis of the tasks set and contributed to the development of substantiated conclusions. In particular, the comparative legal, formal legal method, policy analysis method, empirical method and analysis method were used.

The comparative legal method, which consists in comparing legal norms, institutions and practices of different legal systems to identify common, distinctive and development trends, allowed for a systematic analysis of the compliance of domestic legislation and practice of organizing legal education with common European standards, in particular on the basis of Commission Regulation (EU) No 317/2013 and Commission Regulation (EU) No 912/2013 (European Commission, 2013a; 2013b), which regulate the classification of educational programs and the methodology for generating statistical data in the field of education in the European Economic Area. Thanks to the application of this method, significant discrepancies were identified between Ukrainian regulatory acts, such as the Law of Ukraine "On Higher Education" (Law of Ukraine No. 1556-VII, 2014), Order of the Ministry of Internal Affairs No. 62 (Ministry of Internal Affairs of Ukraine, 2008), Order of the Ministry of Education and Science No. 673 (2020) and Resolution of the Cabinet of Ministers No. 295 (2022), and European requirements for transparency, accreditation and unification of educational programs. It was found that preserving the specifics of training in departmental institutions weakens Ukraine's integration into a single European educational space.

The policy analysis method allowed us to consider strategic documents and concepts related to the reform of legal education in Ukraine, including the Draft Concept for the Development of Legal Education (Verkhovna Rada of Ukraine, 2020), the Manifesto for the Development of Legal Education (Verkhovna Rada of Ukraine, 2020), as well as draft legislative acts and recommendations of international organizations (OSCE, G7, USAID). This method contributed to the identification of trends towards the academization, unification and democratization of legal education, as well as a critical understanding of the policy of preserving individual law schools with their own law programs. The policy analysis showed that such isolation creates risks of fragmentation of the legal labor market, weakens the quality of training and reduces their competitiveness, which contrasts with European trends of integration and unification of educational standards. As a result of the application of this method, recommendations were formulated for changing educational policy towards the integration of law schools into the national educational space.

The formal-legal method made it possible to conduct an in-depth analysis of the regulatory legal acts of Ukraine that regulate the activities of higher education institutions with specific training conditions, in particular the Regulations on Higher Education Institutions of the Ministry of Internal Affairs (Ministry of Internal Affairs of Ukraine, 2008; Ministry of Internal Affairs of Ukraine, 2022), the Law of Ukraine "On Higher Education" (Law of Ukraine No. 1556-VII, 2014), Order of the Ministry of Education and Science No. 673 (2020) and Resolution of the Cabinet of Ministers No. 295 (2022). The use of this method made it possible to clearly identify regulatory conflicts and contradictions, as well as to identify gaps in the regulation of issues of accreditation of educational programs, the right to conduct educational activities and the formation of educational and qualification levels, which actually keep these higher education institutions in the status of isolated structures, failing to receive the necessary guarantees of



academic autonomy and recognition of the national and international community. Such analysis confirmed the need to revise the current regulatory acts in order to harmonize the legal field regulating specific legal education in the system of law enforcement agencies.

The empirical method, which consists of collecting, processing and analyzing quantitative and qualitative data and allows to substantiate or refute hypotheses, to verify theoretical provisions in practice, was based on the analysis of quantitative and qualitative data from the reports of the Accounting Chamber of Ukraine (2019), international OSCE studies, Democracy Justice Reform analytics, official statistical reports of the National Agency for Quality Assurance in Higher Education and the European Commission (European Commission, 2023). This method made it possible to verify hypotheses about the inefficiency of the legal training system in institutions with specific training conditions, to identify disparities between budget expenditures and performance, and to outline problems with compliance with international accreditation standards. Empirical data confirmed the conclusions about the need to reform the education system in these institutions, to ensure greater transparency and accountability, which in the future will contribute to improving the quality of specialist training.

This study adopts a qualitative documentary approach, based on the analysis of national legislation, institutional policies, and ministerial strategies on higher education in Ukraine published between 2020 and 2023.

Thus, the comprehensive use of these methods made it possible to analyze the regulatory, organizational, and political aspects of the problem and to form well-founded conclusions and recommendations for reforming legal education in Ukraine, focused on European integration and improving the quality of specialist training.

Results and Discussion

The process of reforming legal education in Ukraine has become particularly relevant in the context of the country's European integration aspirations, which involve a deep transformation of educational approaches in accordance with European Union standards. One of the most controversial aspects of this reform is the question of the feasibility of training lawyers in higher education institutions with specific learning conditions - in particular, in the system of the Ministry of Internal Affairs, the Security Service of Ukraine and military educational institutions.

The issue of transforming legal education in Ukraine, particularly in the context of higher education institutions with special training conditions, is extremely relevant in the context of the integration of the Ukrainian legal system into the European educational and legal space. The existing system of training lawyers in law enforcement agencies demonstrates a number of deep contradictions between the requirements of a functional, disciplinary-hierarchical approach and the pan-European standards of academic education. In particular, the modern model of legal education in departmental HEIs contradicts the key provisions of the Bologna Process, ISCED-2013 standards and the European Standards for Quality Assurance in Higher Education (ESG), in particular in terms of academic freedom, mobility, university autonomy and openness of the educational process (Eurostat, 2013). Training lawyers in such institutions takes place in conditions of limited external quality assessment, low level of transparency, inaccessibility to the broad labor market outside the law enforcement agencies, which generally undermines both trust in such diplomas and the effectiveness of the system of training specialists itself (OSCE, 2009).

Against the backdrop of the state policy of legal education reform, which since 2024 declares the unification of legal educational programs in all types of higher education institutions, regardless of ownership or subordination, the question of the expediency of the existence of separate legal programs in law enforcement institutions arises. However, such a transformation is complex and contradictory: on the one hand, there is an objective need for personnel for the security and law enforcement sector, on the other hand, preserving the departmental model of education does not allow ensuring compliance with the



requirements of ESG and the European higher education space. Thus, a conflict arises between the needs of the industry and academic standards, which is the fundamental problem of the study. The lack of clear transformation mechanisms, the lack of empirical research on the impact of such changes, as well as weak coordination between the ministries of education, justice and law enforcement agencies – create a risk both for the stability of the legal education system and for the functioning of security sector institutions.

In this context, a number of scientific hypotheses are put forward. First, the existing model of training lawyers in the Higher Educational Institutions of the Ministry of Internal Affairs and the Security Service of Ukraine contradicts the principles of academic autonomy, mobility and accreditation, which makes it impossible to internationally recognize such educational programs. Second, even under the conditions of functional justification of such programs, their isolation from the general education system deepens the gap between the theory of law and its practice, and also preserves departmental approaches that do not meet the principles of European legal culture. Third, the elimination or transformation of these programs without taking into account the personnel needs of the relevant bodies threatens a significant shortage of lawyers in the security sector. Fourth, under the conditions of developing an effective model of interdisciplinary cooperation, it is possible to combine a civilian academic core and industry specialization, which will ensure not only educational quality, but also applied efficiency.

Within the framework of the study of conceptual shifts in the policy of higher legal education in Ukraine in the direction of banning the training of lawyers in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military universities, it is advisable to analyze both the international and national regulatory and legal framework that regulates the relevant educational processes. Retrospective and comparative legal study of the acts of the European Union, as well as Ukrainian legislation, allows us to establish contradictions between current practice and the declared goals of reforming legal education in accordance with European standards.

European Commission (2013a; 2013b) Regulations No. 317/2013 and No. 912/2013 set out the imperatives of unification of educational classifications, as well as the requirements for transparency of statistical indicators regarding education and vocational training systems. They are the regulatory framework for ensuring academic integrity, openness of data on curricula and the effectiveness of specialist training. In the context of legal education, these acts actualize the requirement to bring the training of lawyers into line with the International Standard Classification of Education (ISCED), which provides for the public, academically verified and competitive nature of educational programs. Institutions with special training conditions (in particular, those subordinate to the Ministry of Internal Affairs, the Security Service of Ukraine or the Ministry of Defense) do not provide such conditions, which contradicts the imperatives of European integration in the educational sphere.

Instead, internal regulations, in particular the Regulations on Higher Education Institutions of the Ministry of Internal Affairs of Ukraine (Ministry of Internal Affairs of Ukraine, 2008), establish the functioning of educational institutions with a narrow departmental status, the main task of which is to provide personnel for the internal affairs bodies. These institutions, by their nature, do not comply with the principles of academic autonomy, publicity and universality required by the Law of Ukraine "On Higher Education" (Law of Ukraine No. 1556-VII, 2014). It is this law that declares the rights of applicants to equal access to quality education, academic freedom and quality assurance through independent accreditation. At the same time, law enforcement higher education institutions mostly remain outside the scope of effective external quality control of educational programs. In addition, it is worth noting that in accordance with clause 6-1, part 1, article 1 of the Law of Ukraine "On Higher Education" - a higher education institution with specific training conditions – a state-owned higher education institution that carries out training of cadets (students, students) and adjuncts at certain levels of higher education for further service in middle and senior positions of the National Police of Ukraine, command staff in order to meet the needs of the Ministry of Internal Affairs of Ukraine, the central executive body implementing state policy in the field of civil protection, the central executive body implementing state policy in the field of execution of criminal penalties.

Particular attention should be paid to the Order of the Ministry of Education and Science (Order No. 673,

2020), which establishes a list of specialties, access to which is additionally regulated - in particular, legal. This creates a legal basis for strengthening the regulation of access to the legal profession based on accreditation and transparency. However, the current situation demonstrates that some institutions that train lawyers operate in a non-accredited field or undergo exclusively internal supervision, which contradicts the essence of this regulatory act.

The issue is further updated by the Cabinet of Ministers' Resolution No. 295 of March 16, 2022, which, despite wartime conditions, does not abolish the obligation to accredit, but only adapts the mechanisms to the crisis context. This confirms that even in wartime conditions, the state recognizes the importance of ensuring educational quality, and therefore, training lawyers in unaccredited or closed programs contradicts state policy.

Summarizing the above, it should be noted that the existing legislative framework – both national and European - lays a systemic foundation for reviewing the role of institutions with special training conditions in the legal education system of Ukraine. It provides for mandatory accreditation, openness and civil control as the principles of training lawyers, and therefore the contradictions in the form of functioning of educational programs in institutions of the Ministry of Internal Affairs, the Security Service of Ukraine and military academies need to be resolved through the gradual withdrawal of these institutions from the sphere of general professional legal education. This will meet Ukraine's obligations within the framework of European integration, but will also contribute to the establishment of academic integrity, professional mobility and the formation of an open, independent and competitive legal community.

Statistical data indicate a significant proportion of law students studying in law enforcement agencies. In particular, according to the Ministry of Internal Affairs of Ukraine (2025), in 2023, more than 22 thousand applicants studied in the specialty 081 "Law" at higher education institutions of the Ministry of Internal Affairs, of which more than 65% were on state orders. In turn, according to the Accounting Chamber of Ukraine (2019), the financing of these institutions exceeded 1.4 billion UAH annually, while the effectiveness of the costs raised doubts due to limited access to the legal market for graduates and their further professional segregation.

The European Commission in its Report on Ukraine (2023) clearly emphasizes the need to ensure academic independence and structural separation of legal training from institutionally dependent power formats. Think tanks, in particular Democracy Justice Reform and USAID, in their reports (DeJure Foundation, 2020a; DeJure Foundation, 2020b; G7 Support Group for Ukraine, 2024) emphasize the need to transform the content of legal education, which should be based not on training executors, but on the formation of legal specialists capable of implementing the principles of the rule of law. Thus, the Manifesto for the Development of Legal Education (Verkhovna Rada of Ukraine, 2020) states that departmental educational institutions are not focused on the formation of lawyers capable of critical thinking, but on the education of executors of official instructions, which contradicts the basic values of European legal education.

This problem becomes particularly relevant in conditions of martial law, when the quality of educational programs is further complicated by procedural changes, in particular, in accordance with Resolution of the Cabinet of Ministers of Ukraine No. 295 of March 16, 2022 (2022), which allows simplified accreditation in wartime, which can further reduce the academic quality of training in military higher education institutions.

Against this background, the Concept of Legal Education Reform (Judicial and Legal Newspaper, 2024; European Commission, 2024) and the Concept of Legal Education Development (Verkhovna Rada of Ukraine, 2020) propose a systematic rethinking of approaches to training lawyers, including the gradual elimination of legal programs in law enforcement agencies and the transition to cross-disciplinary academic education based on the Bologna Process and ESG (European Standards and Guidelines for Quality Assurance in Higher Education). These documents provide for the creation of a unified approach to training lawyers, regardless of further specialization, which makes it impossible to operate a "parallel system of

legal education” in departmental structures.

Therefore, the problem of the functioning of law programs in higher education institutions with special learning conditions is not only a part of domestic educational policy, but also an object of international monitoring, critical analysis and legal regulation. Its solution requires a comprehensive interdisciplinary approach taking into account legal, administrative, financial and political factors, which is the subject of this study.

The state of legal education in Ukraine, in particular in the field of training specialists in higher education institutions with specific training conditions (the Ministry of Internal Affairs, the Security Service of Ukraine, military academies), reveals a complex of systemic contradictions between the requirements of the national security sector and the pan-European standards of academic education. The training of lawyers in law enforcement agencies is carried out in conditions of disciplinary subordination, functional subordination of the educational process to departmental interests, which contradicts the principles of academic autonomy, freedom of teaching and critical thinking – the key principles of the Bologna Process and the European Standards for Quality Assurance in Education (ESG).

In connection with the adoption of a number of conceptual documents (National Agency for Higher Education Quality Assurance, 2024), the vector of state policy is focused on the unification of legal education within a single legal space, which calls into question the advisability of maintaining legal programs in law enforcement higher education institutions.

At the same time, the lack of a clear mechanism for implementing such changes, the low level of adaptability of relevant educational institutions, and the lack of a generalized scientific analysis of the consequences of such transformations create significant risks, including:

violation of staffing of internal affairs bodies and the security sector;
the formation of a shortage of practically-oriented lawyers;
worsening imbalance between departmental education and civil academic jurisprudence;
growing legal uncertainty regarding the legitimacy of diplomas of law enforcement graduates in the general legal labor market.

To address the outlined issues, a multi-level approach is proposed. At the regulatory level, it is advisable to adopt a separate law on legal education, which would provide for uniform requirements for all legal programs, regardless of the type of higher education institution, ensuring compliance with ESG, including external independent quality assessment and mandatory accreditation through national and European agencies. At the institutional level, it is optimal to either incorporate law programs of law enforcement higher education institutions into the structure of classical universities while maintaining their specialization in security jurisprudence, or to create separate educational and practical centers of an applied type, such as the Fachhochschule in Germany. At the same time, it is necessary to develop mechanisms for civil-industry cooperation, where security sector practitioners could participate in the training of students in civilian higher education institutions. At the personnel level, a targeted state order should be introduced for law faculties with subsequent mandatory employment in the Ministry of Internal Affairs/SBU/Armed Forces of Ukraine, which will allow maintaining a balance between the quality of education and personnel needs. It is also advisable to introduce mechanisms of dual education with the distribution of theoretical training in classical higher education institutions and practical training - on the basis of law enforcement agencies.

Thus the reform banning legal education within law enforcement and military institutions in Ukraine represents not only an administrative decision but also a profound reorientation of the conceptual foundations underlying professional and academic legal training. This policy reform has important implications for the future configuration of Ukraine’s legal education system, intersecting with broader questions of academic integrity, institutional autonomy, and the professional identity of lawyers in a democratic society.

At the heart of the reform lies the imperative to distinguish between academic legal education and professional or in-service legal training. Academic education in law aims to instill foundational legal reasoning, critical analysis, and ethical reflection. It is grounded in university autonomy, scientific inquiry, and a commitment to universal educational standards, such as those laid out in the Bologna Process and ESG (European Standards and Guidelines for Quality Assurance in Higher Education).

By contrast, professional training within law enforcement institutions has traditionally emphasized functional adaptation, hierarchical discipline, and role-specific competence. While these are legitimate goals for institutions charged with state security and public order, conflating them with academic legal education distorts both spheres. It dilutes the theoretical and normative depth of academic curricula and compromises the impartiality and critical distance expected from legal professionals.

The Ukrainian policy reform asserts that the legal profession – especially under conditions of democratic transformation – requires its foundational training to be embedded in civilian academic settings. This shift reflects a broader European consensus: that legal education must be insulated from political or institutional subordination to maintain its autonomy, foster legal pluralism, and equip graduates for diverse roles in the justice system, academia, and civil society.

A key conceptual element of the reform is the reconfiguration of professional socialization pathways. Historically, many law graduates from police, secret service, and military academies have entered the general legal labor market, not remaining within their “parent” institutions. This has created a problematic dualism: graduates benefit from the prestige of a legal degree while being trained under non-academic, internally controlled regimes lacking transparent quality assurance. The reform seeks to eliminate this contradiction by redefining the purpose of legal programs within law enforcement institutions—not as gateways to the broader legal profession, but as specialized in-service programs tailored to internal agency needs.

Such a distinction aligns with international models, such as the German system, where Fachhochschulen or universities of applied sciences provide practical training, while theoretical instruction is reserved for fully accredited academic institutions. By following this model, Ukraine affirms the democratizing function of higher legal education: it becomes a public good, accessible under equal conditions, guided by meritocratic standards, and accountable to society—not merely to a specific power structure.

One of the most vital conceptual justifications for the reform is the necessity to de-politicize legal education. Departmental universities under the control of internal affairs ministries or military command structures inherently lack autonomy. Their curricula, staffing, and academic governance are influenced – if not determined – by institutional priorities that often conflict with the principles of transparency, open access, and critical pedagogy.

This structural dependence undermines the core values of the legal profession in a rule-of-law state: independence, impartiality, and accountability. The presence of legal education within such frameworks risks producing lawyers whose epistemic and ethical orientation is shaped by institutional loyalty rather than constitutional values or public service. Therefore, the relocation of legal education to autonomous civilian universities is not merely an administrative reshuffling but a foundational reassertion of the normative underpinnings of legal professionalism.

The reform also operationalizes a conceptual commitment to harmonization with European educational and professional standards. The ESG and ISCED frameworks require the legal profession to be built upon transparent, comparable, and quality-assured academic foundations.

The reform prioritizes:

Centralized and standardized accreditation;



Independence of academic programs from institutional hierarchies;
External quality control;
Academic freedom for both students and faculty.

These conditions are virtually unattainable within departmental educational structures. The reform thus embraces institutional isomorphism with European legal education systems, facilitating academic mobility, degree recognition, and professional equivalence across EU jurisdictions.

A legitimate concern accompanying the reform is the potential staffing shortfall in law enforcement and security institutions. However, the conceptual design of the reform already anticipates this. It proposes the development of dual-track training models, combining basic academic legal education in accredited universities with targeted, agency-specific professional training delivered post-graduation. This ensures that legal professionals serving in national security retain both professional competence and academic grounding.

Moreover, mechanisms such as targeted scholarships, mandatory public service contracts, and cooperative education agreements can be employed to align the output of civilian universities with sectoral needs – without compromising academic independence.

Ultimately, the Ukrainian reform marks a paradigm shift in the legal education ecosystem. It moves away from a fragmented, dual-track model toward a unified, academically grounded system. It clarifies the conceptual boundary between legal knowledge as a civic and intellectual pursuit versus legal training as an administrative function.

This shift resonates with global trends in higher education reform and supports Ukraine's broader objectives of European integration, democratization, and legal modernization. By elevating the standards and structure of legal education, Ukraine strengthens the foundations of its legal profession, enhances public trust in the justice system, and equips its future lawyers to act as guardians of the rule of law rather than as instruments of state apparatus.

Conclusions

Analysis of the regulatory framework governing the training of lawyers in law enforcement institutions has shown the existence of a specific regulatory regime that allows for educational activities outside the single academic space. In particular, such institutions operated on the basis of internal departmental acts that limited their accountability to the National Agency for Higher Education Quality Assurance and other bodies authorized to carry out external quality control of education. Despite the formal presence of specialty 081 "Law" in the list of licensed areas of training, the content of educational programs, the methodology of their implementation, access to scientific resources and institutional openness in many cases did not meet the criteria of the International Standard Classification of Education (ISCED 2013), the provisions of the ESG and the basic principles of the Bologna Process. The educational process in departmental HEIs did not provide for wide access to academic mobility, international cooperation, or independent scientific and methodological support, which, in aggregate, contributed to the formation of a closed model of legal training with reduced quality requirements.

The research revealed key conceptual changes in the state's educational policy, which became the basis for the termination of the training of lawyers in the system of the Ministry of Internal Affairs, the Security Service of Ukraine and the Armed Forces of Ukraine. Work on the concept of the development of legal education, as well as the implementation of European standards in the field of accreditation of higher education, highlighted the need to unify legal training within the civilian educational space. The results of external audits, including the conclusions of the Accounting Chamber and recommendations of international partners (USAID, European Commission), showed the absence of transparent quality assurance mechanisms, an insufficient practical component of educational programs, as well as significant discrepancies between the programs of departmental HEIs and the standards approved by the Ministry of

Education and Science. The political and administrative decision to gradually eliminate legal education programs in the security sector became a logical continuation of reforms aimed at strengthening the rule of law, establishing the rule of law and the European integration of Ukraine.

The prospects for further development of the legal education system are determined, taking into account European integration obligations. Within the framework of this approach, the need for the final harmonization of educational standards with the provisions of the ESG, as well as the transformation of the model of training lawyers towards an open, academically autonomous and quality-controlled environment, is substantiated. The priority direction is the implementation of a dual education model, which involves obtaining basic legal education at universities that meet national accreditation criteria, with subsequent professional specialization in departmental training centers. Such an approach will ensure the unity of standards, avoid fragmentation of the educational field and create a basis for effective professional training of lawyers in the national security system. In addition, it is proposed to strengthen the role of the National Agency for Higher Education and Science in monitoring the quality of legal programs regardless of the form of ownership and departmental subordination of the institution, as well as the introduction of external international monitoring of educational standards in the field of law.

Overall, the results of the study indicate a critical need to move from a departmentally closed model of legal education to an open, European-oriented system based on quality, academic integrity, mobility, and transparency. Such an approach is consistent with Ukraine's long-term strategic priorities, in particular, strengthening democratic institutions, strengthening the legal foundations of the civil service, and establishing a single legal space in higher education.

Regarding further scientific research, we consider it appropriate to conduct a comparative analysis of legal education models in the law enforcement agencies of the EU and NATO countries.

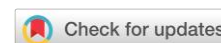
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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.18>

Cómo citar:

Lutsenko, I., Leshchenko, H., Prots, T., Gvozdetzka, S., & Omok, H. (2025). Classification of innovations and challenges in teaching physical education in the digital age. *Revista Eduweb*, 19(2), 266-279. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.18>

Classification of innovations and challenges in teaching physical education in the digital age

Clasificación de innovaciones y desafíos en la enseñanza de la educación física en la era digital

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Recibido: 21/04/25

Aceptado: 27/06/25

Abstract

Introduction: Digitalization in the field of physical education requires additional assessment. The purpose of the article is to conduct a systematic analysis of new innovative solutions and key problems of their implementation in the process of teaching physical education in the era of digital technologies. Methods: The PRISMA scientific approach was used, which made it possible to identify the most relevant scientific sources (n=40). Time range: 2017-2025. The content analysis method was used to process the materials. Results: The following types of



digital innovations were identified: mobile applications and platforms, gamification, artificial intelligence, intelligent educational ecosystems, wearable technologies, inclusive digital tools, flipped learning, and virtual and augmented reality technologies. There are serious challenges to their application: insufficiently developed digital infrastructure in educational institutions, low level of digital literacy of physical education teachers, pedagogical inconsistency, technological challenges, and psychophysiological limitations. For the further use of digital technologies, a classification of innovative solutions is proposed. It is proposed to distinguish such solutions by functional direction, degree of interactivity, format of use, and general purpose. Conclusions: The conclusions emphasize the importance of continuing research, since digitalization in the educational dimension is constantly developing.

Keywords: innovative technologies, physical education, digitalization, classification.

Resumen

Introducción: La digitalización en el campo de la educación física requiere una evaluación adicional. El propósito del artículo es realizar un análisis sistemático de nuevas soluciones innovadoras y problemas clave de su implementación en el proceso de enseñanza de la educación física en la era de las tecnologías digitales. **Métodos:** se utilizó el enfoque científico PRISMA, que permitió identificar las fuentes científicas más relevantes (n=40). **Rango temporal:** 2017–2025. Para el procesamiento de los materiales se utilizó el método de análisis de contenido. **Resultados:** Se identificaron los siguientes tipos de innovaciones digitales: aplicaciones y plataformas móviles, gamificación, inteligencia artificial, ecosistemas educativos inteligentes, tecnologías wearables, herramientas digitales inclusivas, aprendizaje inverso, tecnologías de realidad virtual y aumentada. Existen serios desafíos para su aplicación: infraestructura digital insuficientemente desarrollada en las instituciones educativas, bajo nivel de alfabetización digital de los profesores de educación física, inconsistencia pedagógica, desafíos tecnológicos y limitaciones psicofisiológicas. Para un mayor uso de las tecnologías digitales, se propone una clasificación de soluciones innovadoras. Se propone distinguir dichas soluciones por dirección funcional, grado de interactividad, formato de uso y objetivo general. **Conclusiones:** Las conclusiones enfatizan la importancia de continuar la investigación, ya que la digitalización en la dimensión educativa está en constante evolución.

Palabras clave: tecnologías innovadoras, educación física, digitalización, clasificación.

Introduction

The active application of digital technologies and new innovative solutions is changing the modern educational environment. However, unlike many other fields of education, physical education has its own unique needs, limitations, and potential in the digital environment, which requires a separate analysis. The current scientific literature indicates that modern physical education plays an important role in the formation of a healthy lifestyle, development of motor skills, physical endurance, and psychosocial well-being of students (Martínez-Rico et al., 2021; van Hilvoorde & Koekoek, 2018). However, its specificity, namely the focus on physical activity, interaction in the real environment, and bodily presence, creates special challenges for the implementation of digital innovations (Goodyear & Armour, 2022). At the same time, modern technologies, such as wearable devices, mobile applications for activity monitoring, and gaming platforms with exercise elements, allow us to unlock the potential for motivation in students and apply a personalized approach to teaching (Otravenko, 2020; Almusawi et al., 2021). In particular, the research by Almusawi et al. (2021) indicated that the use of digital technologies had a positive effect on increasing the level of motivation. Authors pointed out that analytics can improve the personalization of learning. It has been proven that the use of innovative technologies also increases the level of student interest (O'Brien et al., 2020; Ferriz-Valero et al., 2020). However, the scientific literature also emphasizes that the introduction of digital technologies has its limitations (high cost, problems with technical equipment) and specifics in use (the need for digital competencies) (Chiu et al., 2024; Lee & Lee, 2021; Deng et al., 2023). Despite the active implementation of digital solutions and, in some situations, their adaptation process in physical education, the scientific literature still lacks a systematic approach to their classification. There are no generalized typologies of innovations, and the specific difficulties faced by teachers in implementing these technologies have not been sufficiently studied. Accordingly, such nuances make it difficult to



formulate effective strategies for integrating digital tools into physical education teaching practice. In addition, the relevance of this study is due to the need for a meaningful and structured approach to the digital transformation of physical education, which is currently lacking in the scientific space. Accordingly, the scientific novelty of the work is an attempt to systematize the existing innovations and challenges based on the analysis of modern scientific literature (from 2017 to 2025). This will help to form an important scientific basis for more effective implementation of technologies in this area.

Thus, the purpose of the study is to conduct a detailed systematic analysis of new innovative solutions and key problems of their implementation in the process of teaching physical education in the digital age.

Accordingly, the research questions are as follows:

1. What are the types of digital innovations that are actively used in the physical education system?
2. What are the main difficulties faced by teachers in implementing these innovations?
3. What classification can be proposed for innovative solutions to support the systemic integration of digital technologies in physical education practice?

Methodology

Research design

The study was created as a result of a systematic review of the scientific literature. The purpose of using this approach was to analyze and interpret the results in relation to predefined research topics and criteria that demonstrated the existence of potential areas for future research. A systematic review of the scientific literature is a type of research that is important because it systematizes the existing knowledge on the use of AI, which is currently lacking in the scientific literature.

Materials

The selection of sources was based on a purposive sampling carried out according to established criteria. The research involved the use of various types of sources: scientific articles, chapters of monographs, individual monographs, materials of scientific conferences, etc. An important aspect was the use of materials that were indexed in the scientific and metric databases Scopus, Web of Science, etc. The selection was made taking into account the chronological range from 2017 to 2025. This approach made it possible to use only the most relevant scientific literature and the latest sources in the study. In addition, we emphasized the reliability of scientific literature and certain methodological aspects. Relevant content is another additional criterion. The main language of scientific publications is English. Table 1 summarizes the main criteria used to include and exclude sources.

Table 1.
Inclusion and exclusion criteria of publications

Criterion	Description
Inclusion criteria	
Chronological framework	Research 2017-2025
Authority of sources	Articles, which were published in peer-reviewed journals or scientific monographs
Quality of methods	Papers and monographs of various methodological types (for example, review materials, experimental data, analyses etc).
Aspect of relevance	All papers and monographs must relate to the problem of the proposed paper
Language of publication	English
Exclusion criteria	
Outdated sources	Papers and monographs written before 2017
Duplicates	All duplicates and similar scientific works
Non-peer-reviewed publications	Fiction publications and popular science articles without scientific confirmation
Lack of full text	Only full accessed publications were used



Instruments and Procedure

The PRISMA scientific approach was used to search, classify and review the scientific literature. This allowed us to effectively collect new scientific and relevant information. The keywords for the search were the search queries included the following keywords: “physical education”, “digital innovations”, “challenges”, “ICT in PE”, “technology in education”. In total, the search yielded 2292 results. After eliminating all duplicates and materials that lacked scientific novelty, the list was updated (-1103). Those materials that were not relevant to the subject matter of the proposed article were rejected. Such actions were the result of an analysis of keywords and titles (-814). Similarly, other publications that, although relevant to the topic, were published in journals that did not meet the search criteria were eliminated (-231). After that, the remaining 4 exclusion criteria were used. Figure 1 shows all the stages of inclusion of scientific sources.

Data analysis

Further processing of scientific sources took place in accordance with the use of the method of content analysis. The content analysis process in this study was carried out in stages using a combined approach, which included both manual thematic coding and preliminary organization of sources in the Zotero software environment. Zotero was used to collect, categorize and systematize sources according to basic parameters: year, country, educational context, type of innovation, availability of empirical data, etc. This made it possible to simplify the application of inclusion/exclusion filters and structure the data for further interpretation.

The content analysis involved thematic coding with elements of open coding. The first stage involved open coding, during which the researchers manually identified key ideas, terms, types of innovations and challenges mentioned in the texts. These codes were grouped into generalized themes: for example, “automated assessment”, “VR/AR”, “gamification”, “lack of teacher training”, “low physical activity”, etc.

The second stage involved coding, which identified logical connections between themes and performed higher-level grouping. This allowed the codes to be summarized into four functional categories, which later formed the basis of the proposed classification of educational innovations:

Hence, as a result of content analysis, recurring phenomena, individual themes and innovative approaches were identified, which demonstrate modern practices and individual main challenges:

- Using of digital platforms;
- Current innovative instrument;
- Gamification;
- Automatic assessment;
- VR and AR technologies;
- Insufficient physical activity;
- Lack of teacher training;
- Technical limitations.

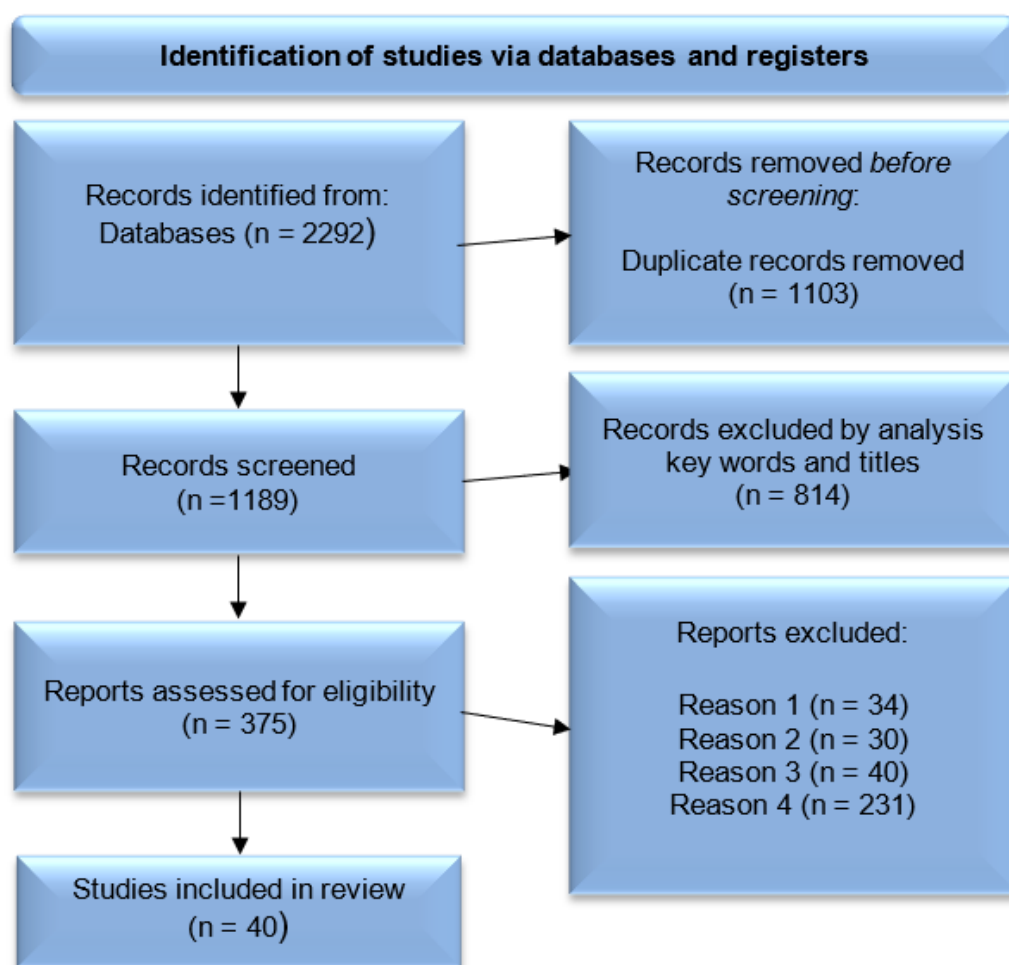


Figure 1. The process of searching and identifying scientific materials

The information obtained was structured accordingly using induction and deduction methods. Individual innovations were highlighted taking into account their functional purpose (motivational, pedagogical, structural and organizational, etc.), and challenges - according to the source of origin (scientific and pedagogical, technological, social, etc.). The use of this method made it possible to carry out a general understanding of the information and form a systemic idea of the state of physical education in times of total digitalization.

Results and Discussion

The selected scientific materials (40 references) discuss several types of digital innovations that are actively used in physical education. First, there are the so-called wearable technologies: various smartwatches, fitness trackers, and other sensors that allow students and teachers to track their heart rate, number of steps, calorie consumption, and the duration and intensity of classes. Mobile workout apps, instructional videos, and fitness programs also play an important role in today's digital learning space. Educational platforms and networks are used to provide a variety of assignments and feedback. An important trend that has recently become popular in the academic space is the use of virtual and augmented reality. Such technologies have made it possible to create interactive spaces for classes, while AR technologies can visualize the correct technique for performing exercises in real time. A noticeable trend that has been

actively implemented in physical education in recent years is gamification, which increases the level of students' motivation to play sports. Analytical systems and AI technologies represent a separate area in the modern scientific space, as they automate assessment and provide personalized recommendations. Table 2 shows the main innovative technologies, their descriptions, and references to relevant authors.

Table 2.
The main innovative technologies

Innovation Type	Short description	Sources
Mobile Apps & Online Platforms	• Online lessons, video instructions, applications, remote interaction, interactive platforms • Video lessons in different networks	Almusawi et al. (2021) O'Brien et al. (2020)
Gamification	• Using game elements: points, competitions	Ferriz-Valero et al. (2020) Zhouxiang (2024) Dzhym et al. (2023)
Analytics & Artificial Intelligence (AI)	• Automatic assessment, personalized lessons, movement recognition	Chiu et al. (2024) Lee & Lee (2021) Deng et al. (2023) Zhang (2021) Brem et al. (2023) YanRu (2021)
Intelligent Educational Ecosystems	• Integrated learning management systems using big data and AI • Digital fitness technology	Deng et al. (2023) Rudd et al. (2020) Freitas et al. (2024) Dzhym et al. (2023)
Wearable Tech	• Fitness trackers, smart technological tools, smart watches, sensors for monitoring student activity • Digital fitness technology	Almusawi et al. (2021) Oke & Fernandes (2020) Shepelenko et al. (2023) Kang (2024)
Inclusive Digital Tools	• Tools to support students with special needs	Chiu, Tochilnikova, & Hartevelde (2024) Dzhym et al. (2023) Shepelenko et al. (2023)
Flipped Learning	• Theory - online, practice - in class	Hinojo Lucena et al. (2019)
Digital Assessment Platforms	• Automatic assessment, analysis of results, adaptive learning	Zhang (2021) Brem et al. (2023) Shepelenko et al. (2023) Freitas et al. (2024) Dzhym et al. (2023)
Virtual & Augmented Reality (VR/AR)	• VR games and simulations for physical activity • Visualization of the correct technique for performing exercises • Digital fitness technology	Chiu et al. (2024) Shepelenko et al. (2023) Craig et al. (2024) Röglin et al. (2023) Kang (2024) Lin et al. (2024)

Overall, content analysis was conducted using a thematic coding approach that combined elements of open and axial coding. The next step in open coding was to identify recurring patterns and key concepts across the 40 selected documents. Each document was read line by line, and initial codes were generated inductively based on the terminology, pedagogical frameworks, and technological elements present in the texts.

Axial coding was then used to establish connections between the initial codes and group them into broader categories, such as "Mobile and Online Technologies," "Gamification," "Artificial Intelligence," "Wearable Technologies," "Inclusive Tools," "Digital Assessment," and "VR/AR." These categories emerged organically during the iterative coding process and were refined based on the frequency of occurrence,

conceptual similarity, and educational applicability of each innovation.

All analysis was conducted manually, without the use of specialized software. However, to ensure methodological rigor, the process was guided by a pre-defined coding protocol developed during the pilot phase of the study. Coding sheets were used to track and synthesize data across documents.

The analysis was conducted by a team of three researchers with expertise in educational technology and qualitative methods. Each researcher independently coded a subset of the documents. To ensure inter-coder reliability, a sample of 20% of the documents ($n = 8$) was double-coded by all three researchers. Cohen's Kappa coefficient was calculated for key categories, yielding $\kappa = 0.82$, indicating strong agreement. Disagreements in coding were discussed in consensus meetings, and final coding decisions were made collaboratively to enhance internal validity. Iterative refinement of categories and codes allowed the team to reduce subjectivity and increase the reliability of the results. Zotero was used to organize the bibliography and apply criteria for inclusion and exclusion of sources. It allowed to standardize the metadata of publications and avoid duplication. Table 3 shows a summary table with the analysis of research, types of innovations, educational context and countries.

Table 3.
Summary table of innovation analysis content

Author(s)	Year	Type of Innovation	Educational Context	Country/ Region	Main Findings
Almusawi et al.	2021	Mobile Apps, Wearable Tech	Higher Education, PE	Oman	Mobile and wearable tools increase engagement and track fitness metrics.
O'Brien et al.	2020	Mobile Apps	Online Learning	USA	Interactive apps improve student motivation and participation.
Ferriz-Valero et al.	2020	Gamification	PE, Blended Learning	Spain	Game mechanics enhance enjoyment and physical activity.
Zhouxiang	2024	Gamification	Digital PE	China	Promotes competition and collaborative learning.
Dzhym et al.	2023	Gamification, AI, Inclusive Tools	Physical Education (PE)	Ukraine	Multifaceted innovations improve accessibility and personalization.
Chiu et al.	2024	AI, VR/AR, Inclusive Tools	Smart Classrooms	Taiwan	AI and VR personalize and visualize learning effectively.
Lee & Lee	2021	AI	Remote Education	South Korea	Movement recognition algorithms improve motor skill learning.
Deng et al.	2023	AI, Ecosystems	Digital PE	China	AI platforms automate assessment and personalize PE instruction.
Zhang	2021	AI, Assessment	Online Platforms	China	Adaptive assessment enables differentiated learning.
Brem et al.	2023	AI, Assessment	Online Higher Ed	Switzerland	Predictive analytics enhance student outcomes.
YanRu	2021	AI	Smart PE	China	Personalization via machine learning increases engagement.
Rudd et al.	2020	Ecosystems	Digital Health Education	UK	Platforms support interdisciplinary health and PE delivery.
Freitas et al.	2024	Ecosystems, Assessment	Online and Hybrid Learning	Brazil	LMS and adaptive systems improve inclusivity and feedback loops.
Oke & Fernandes	2020	Wearable Tech	School-based PE	Nigeria	Wearables foster student autonomy and health awareness.
Shepelenko et al.	2023	Wearables, Inclusive, Assessment, VR	Blended PE, Inclusion	Ukraine	Multimodal innovations ensure accessibility and individual tracking.
Kang	2024	Wearable Tech, VR	Smart PE	South Korea	Sensors and VR enhance physical technique visualization.
Hinojo Lucena et al.	2019	Flipped Learning	Pre-service Teacher Training	Spain	Blended formats improve practical application of theoretical content.
Craig et al.	2024	VR/AR	K-12 PE	Canada	VR boosts student engagement and realism of physical instruction.

Röglin et al.	2023	VR/AR	Higher Education	Germany	Immersive learning improves motor skill retention.
Lin et al.	2024	VR/AR	PE and Health Education	Taiwan	Enhances visualization and safety in movement instruction.
Chiu et al.	2024	Inclusive Tools	Smart Inclusive PE	USA/Ukraine	Tech integration improves support for students with disabilities.
Shyshkina et al.	2023	Individualized fitness training programs	Fitness and Wellness	Ukraine	Individualized fitness training improves psychophysiological satisfaction
Tjønnal	2017	Typology development of sport innovation	Sport and Physical Education	Norway	Proposed a comprehensive typology of sport innovations
van Hilvoorde & Koekoek	2018	Digital technologies in PE	Physical Education	Netherlands	Discussed integration of digital tech to modernize PE
Bogetz et al.	2015	Professional training innovations	Healthcare Education	USA	Highlighted new training models preparing healthcare professionals for 21st-century practice demands.
Davison & Joia	2022	Digital transformation challenges	Higher Education, Digital	Latin America	Analyzed opportunities and barriers for digital transformation in Latin American educational institutions.
Deroncelle-Acosta et al.	2023	Digital transformation post-COVID-19	Higher Education	Latin America	Explored impacts of digital innovation in higher education
Patiño et al.	2023	Active learning & Education 4.0	Open Education	Latin America	Demonstrated effectiveness of active learning approaches for complex thinking
Popovsky	2020	Online education innovation	Higher Education	Latin America (Argentina)	Presented Universidad de Palermo as a model for innovative online education
Rodríguez-Abitia et al.	2020	Addressing digital gap in universities	Higher Education	Mexico, Spain	Identified challenges in bridging digital divide to improve quality education in universities.
Li & Wang	2021	AI-based PE teaching methods	Higher Education	China	Demonstrated effectiveness of AI methods to enhance PE teaching outcomes in college students.
Martínez-Rico et al.	2021	Digital competence of PE teachers	Physical Education	Spain	Assessed PE teachers' readiness for digital challenges, identifying competence gaps.
Mishra et al.	2024	AI-driven analytics for training	Sports Education	Global	Proposed AI analytics model to optimize training and injury prevention in sports PE.
Myronenko et al.	2022	Healthy lifestyle promotion via sports	Sports Education	Ukraine	Studied formation of healthy lifestyles through sports activities and education.
Nikolaienko et al.	2022	Long-term training systems for footballers	Sports Training	Various (International comparison)	Analyzed features of long-term football training systems in different countries.
Cui et al.	2024	Multilevel modeling of tech use	Physical Education	China	Found positive correlations between tech use, student engagement, and improved fitness outcomes in PE classes.
Barrantes Cáceres, & Cozzubo Chaparro	2017	Intergenerational internet learning	Lifelong/Informal Education	Latin America	Showed the role of intra-household learning in increasing internet use by older adults.
Trabelsi et al.	2021	Tech-mediated teaching practices	Physical Education	Tunisia	National survey shows uneven access to and use of digital tools by PE teachers in public schools.

While digital technologies are actively used and their potential for modernizing the physical education system is recognized in science, the scientific literature indicates that the process of their introduction and use contains serious challenges. The latter differ from the local character and have technological, social, pedagogical and ethical aspects. In particular, an important challenge is the insufficiently developed digital infrastructure in educational institutions. In particular, some institutions do not have the necessary devices, such as fitness trackers, VR headsets, multimedia equipment, or the technical capabilities to use



them fully (Internet, professional technical support) (Davison & Joia, 2022). Another problem is the low level of digital literacy of physical education teachers. According to current research, a significant number of teachers have a limited understanding of modern EdTech solutions or lack the skills to use them. This situation generally causes resistance to innovation, which is aggravated by the lack of proper training. On the other hand, there is a pedagogical inconsistency (Deng et al., 2023; Patiño et al., 2023). The point is that innovations are often implemented in fragments, without appropriate methodological justification or adaptation to the specifics of physical activity. Technological challenges are highlighted, including problems with personal data protection and inequality of access to digital technologies among applicants (Cui et al., 2024). Separately, the scientific literature highlights psychophysiological limitations associated with long-term use of technology. It has been proven that they can lead to fatigue, disorientation, and coordination disorders. Besides, further implementation of these technologies should take these challenges into account and create an effective digital learning environment.

Moreover, the results of the content analysis directly became the basis for constructing the proposed functional classification of educational innovations in the field of physical education and higher education. During the analysis, thematic coding and grouping of materials from selected publications was carried out, focusing on the nature of the use of technologies, pedagogical goals, and educational context (See Figure 2).

1. According to the functional area	Educational technologies: digital simulators, videos, AR/VR platforms, digital learning resources, additional electronic materials
	Organizational and communication technologies: Online educational platforms, digital resources for distributing and storing materials, assignments, assessments
	Motivational technologies: digital resources, platforms, gadgets, applications that include game elements, rankings, competitions, achievements
2. By the degree of interactivity	Passive (content-oriented) technologies: videos, text instructions that do not provide feedback
	Active technologies: services that adapt to the mobile actions of seekers
	Intelligent technologies: Tools with elements of artificial intelligence that analyze data and generate recommendations
3. By format of use	Individual technologies: personal trackers, mobile applications
	Collective technologies: digital games, VR classes in a group format
	Institutional platforms: comprehensive systems integrated into the school IT infrastructure
4. By purpose (goal)	Conducting assessments: analyzing data on the activity, success, or physical performance of applicants
	Direct training: digital resources that provide information, video content, support for the process of mastering movement techniques or various exercises
	Feedback: self-monitoring apps, teacher comments, digital portfolios

Figure 2. Classification of identified innovations



The classification created by the authors will allow teachers to comprehensively assess existing digital solutions and select appropriate technologies according to educational goals and student characteristics. This classification is also aimed at developing strategies for the gradual introduction of innovations into the educational process. Considering the main goal of the study, namely, conducting a systematic analysis of selected scientific literature and forming a classification of the main identified innovations based on this, it is proven that various digital technologies for the development of physical culture are identified in the modern scientific space.

The study proves that adaptive learning platforms, artificial intelligence technologies, fitness devices, mobile applications for tracking activity and sports activities, virtual reality using EdTech capabilities are integral components of the current educational process. Thus, the results obtained determined the presence of a wide range of digital innovations that are actively used in physical education. These data are partially consistent with the results of other scientists, who determined the impact of digitalization on improving the motivational level of students (Li & Wang, 2021). In addition, these data are compared with the study by Lee & Lee (2021) which emphasized the potential of AI in the system of adapting training programs to the individual needs of students. Other studies have proven the importance of AI for conducting physical condition analytics (Shyshkina et al., 2023; Nikolaenko et al., 2022). The results of the study identified several main problems: technical (lack of equipment), pedagogical (lack of proper training of teachers) and ethical problems (data confidentiality). In general, the proposed difficulties are fully consistent with the conclusions of previous scientists. However, the work of O'Brien et al. highlighted other important difficulties. These authors emphasized such a phenomenon as the inequality of digital infrastructure between educational institutions (O'Brien et al., 2020; Bogetz et al., 2015). At the same time, other works recorded the low readiness of teachers to integrate wearable technologies. At the same time, other scientists recorded the current problem of legal regulation of biometric data collection (Popel et al., 2023; Omelchuk et al., 2022). The difficulties identified in the discussion contribute to the improvement of existing digital technologies used in modern physical culture (Devadze & Gechbaia, 2024; Pathak, 2023). The last research question concerned the formation of a classification of the main modern digital innovations in physical education. Accordingly, as a result of the analysis, a functional-typological classification of digital innovations in physical education was proposed. It involves a division by functional purpose: 1) control and monitoring (wearables, artificial intelligence); 2) motivational support (gamification, digital ratings); 3) educational interaction (VR/AR, distance learning); 4) adaptability and inclusion (AI analytics, platforms for inclusive learning). In addition, the developed classification involved paying attention to such components as the purpose of involving technologies (goal) and the format of use (group, individual, institutional use). At the same time, similar approaches can be traced in the works of other scientists (Myronenko et al., 2022). In particular, the study by C. Deng et al proposed the concept of "Smart PE" (Deng et al., 2023). This concept involves structuring innovations by educational functions. At the same time, in the study of Zhang (2021), the formed classification is based on the degree of automation of the educational process. Therefore, modern scholars fully agree that the use of digital technologies in teaching physical education requires a systemic approach, and such classifications are useful for teachers who can choose certain technologies according to their functions, purpose or format (Yang, 2024; Tjønndal, 2017). Therefore, the proposed classification makes it possible to expand existing approaches, since it takes into account not only the technological nature of innovations, but also their pedagogical significance. This generally contributes to the systemic integration of digital solutions into the practice of physical education and sports. The study has limitations. Regarding language coverage, the review was limited to publications in English. This was due to the need to ensure comparability, academic validity, and full-text availability from international databases. At the same time, it is recognized that such a limitation could have led to the omission of relevant sources, in particular from regions where the Spanish language predominates - for example, from Latin American countries or Spain. This potentially affected the representation of local innovative practices. This affects the omission of the latest or highly specialized innovations that are in the non-English-speaking academic space. However, studies by authors from Latin America, the USA, and China, written in English, were used.



Conclusions

Therefore, a systematic analysis of new innovative solutions and key problems of their implementation in the process of teaching physical education in the age of digital technologies demonstrated that this problem is extremely relevant. In particular, the types of digital innovations that were quite actively used in the system of physical education were determined. Among such innovations are characterized mobile applications and platforms, gamification, artificial intelligence, intelligent educational ecosystems, wearable technologies, inclusive digital tools, flipped learning, and virtual and augmented reality technologies.

However, even considering all the advantages of using digital technologies, there are serious challenges to their application. First, among the challenges identified is the insufficiently developed digital infrastructure in educational institutions. Another relevant problem is the low level of digital literacy of physical education teachers, which contributes to the formation of pedagogical inconsistency. On the other hand, it is also worth highlighting technological challenges and psychophysiological limitations associated with long-term use of technology.

The presence of so many barriers indicates a deep structural inequality in access to digital innovations, which complicates their mass and uniform implementation. Therefore, the priority areas of action should be investments in the digital infrastructure of educational institutions, the development of national programs to improve the digital competence of teachers, as well as the adaptation of digital solutions to vulnerable conditions. The functional classification of digital innovations proposed in the study has practical value. It can be useful for teachers (for selecting appropriate digital tools according to pedagogical goals), curriculum authors (a guide for incorporating innovations into the structure of a lesson or module) and managers and educational policymakers (for strategic planning of the integration of EdTech into physical culture). The limitations of the study lie in the language sample, since only English-language sources were included in the analysis, which probably led to an underrepresentation of innovations from Latin American, Spanish or Francophone African countries. There is also no clear segmentation of results by education level.

Therefore, in further research, it is advisable to focus on empirically assessing the effectiveness of each type of innovation in the context of physical education and developing teacher training models that take into account both technical and psychological and pedagogical aspects of digitalization

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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.19>

Cómo citar:

Molodtsova, V., Hrechanyk, N., Guoxi, R., Khoroshailo, O., & Fadyeyeva, I. (2025). The significance of artificial intelligence in fostering professional competencies of the future: a systematic review. *Revista Eduweb*, 19(2), 280-295. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.19>

The significance of artificial intelligence in fostering professional competencies of the future: a systematic review

La importancia de la inteligencia artificial en el fomento de las competencias profesionales del futuro: una revisión sistemática

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Recibido: 21/04/25

Aceptado: 27/06/25

Abstract

The purpose of this study is to conduct a systematic review of relevant materials published between 2018 and 2025, with a focus on analysing the advantages and disadvantages of AI adoption. PRISMA guidelines were applied to search, screen and partially analyse the scientific literature. A total of 54 sources were selected, including experimental papers, review studies, monographs, conference proceedings and analytical articles. The systematic review proceeded in three phases: (1) analytical reading, (2) screening



and (3) examination and reporting. The results show that numerous studies emphasise the potential benefits of emerging technologies, beginning at school level and, consequently, the preparation of teachers to integrate them creatively. Among the studies reviewed, 39% were experimental studies (EXP), while 36% were theoretical reviews (TR). Most of the studies were conducted in higher education institutions with the participation of students and teachers. Methodologically, researchers have mainly undertaken theoretical and survey-based investigations of AI use, although experimental studies are also noteworthy. The conclusions suggest that, given the rapid evolution of digital technologies, an integrated approach combining empirical and theoretical research is optimal for determining the impact of AI systems on the formation of professional competences.

Keywords: automation, critical thinking, opportunities, risks, professional competence, educational process.

Resumen

El objetivo de este estudio es realizar una revisión sistemática de materiales relevantes publicados entre 2018 y 2025, centrada en analizar las ventajas y desventajas de la adopción de la inteligencia artificial (IA). Se aplicaron las directrices PRISMA para la búsqueda, selección y análisis parcial de la literatura científica. Se seleccionaron 54 fuentes, entre ellas artículos experimentales, estudios de revisión, monografías, actas de congresos y artículos analíticos. La revisión sistemática se llevó a cabo en tres fases: (1) lectura analítica, (2) cribado y (3) examen e informe. Los resultados muestran que numerosos estudios destacan los beneficios potenciales de las tecnologías emergentes desde la etapa escolar, así como la preparación del profesorado para integrarlas de manera creativa. Del total de estudios revisados, el 39 % fueron investigaciones experimentales y el 36 % revisiones teóricas. La mayoría se desarrollaron en instituciones de educación superior con participación de estudiantes y docentes. Metodológicamente, predominaron las investigaciones teóricas y basadas en encuestas, aunque los estudios experimentales también fueron significativos. Las conclusiones indican que, dada la rápida evolución de las tecnologías digitales, un enfoque integral que combine investigación empírica y teórica resulta óptimo para evaluar el impacto de la IA en la formación de competencias profesionales.

Palabras clave: automatización, pensamiento crítico, oportunidades, riesgos, competencia profesional, proceso educativo.

Introduction

The contemporary labour market is undergoing radical change owing to the digital transformation of society. Modern professionals must therefore demonstrate appropriate competencies alongside adaptability and flexibility. Artificial intelligence (AI) is a principal driver of these transformations and is being actively integrated into education. According to the World Economic Forum in 2023, more than 40% of essential skills are expected to change by 2027 and more than 85 million jobs could be displaced by artificial intelligence, while 97 million new roles could emerge that are more adapted to human-machine collaboration. Recent studies observe that technology-enhanced learning expands opportunities for developing professional competencies (Bond et al., 2021). Yet new challenges are emerging. Investigation of AI's role in future competency frameworks is timely, since traditional training methods are losing effectiveness amid rapid shifts in skill demands and automation. Technological progress thus underpins the relevance of the present study. Evidence confirms that AI is becoming a powerful educational tool and is promoting personalised learning (Essel et al., 2022). Moreover, AI is one of the key drivers of changes and is being integrated into the education system. According to reports from World Economic Forum in 2023 and empirical research by Essel et al. (2022) AI is being implemented in secondary and higher education to develop personalized learning, automated feedback, and adaptive assessment of knowledge. By analysing individual learner profiles, AI can refine teaching strategies. Nevertheless, implementation faces critical barriers. Access to technology remains uneven (Makransky & Lilleholt, 2018; Ramadhona et al., 2022); deploying AI requires substantial resources and may widen the digital divide. Moreover, particular algorithms can introduce bias in assessment and in the design of learning pathways.



Several research gaps persist. Core future competencies that can be delineated through AI are not yet fully defined, and integration of AI into traditional education remains problematic. Inconsistent methodological approaches and multiple ethical concerns further complicate adoption. Consequently, the central research problem is to establish how AI can foster competencies aligned with labour market needs.

The present study adopts a critical systematic review, whereas most prior work has examined only isolated aspects of AI's educational impact. This approach enables a holistic appraisal of AI's contribution to the formation of professional competencies. Thus, this study responds to these challenges and offers a critical systematic review of the literature. Unlike previous studies that have only considered individual aspects of the impact of AI on education, this review aims to comprehensively assess the potential of AI in shaping professional competencies that meet the requirements of the modern labor market.

Aim: to conduct a systematic review of AI's role in shaping future professional competencies and to evaluate its broader effects on the education system.

Objectives

Undertake a comprehensive search, selection and analysis of recent publications (journal articles, monographs, conference proceedings) on AI's influence on competency formation.

Identify key trends and mechanisms through which AI supports the development of professional competencies.

Determine the principal challenges associated with AI deployment and propose directions for future research on innovative educational technologies that cultivate relevant competencies.

Literature Review

The research is based on several concepts, including the transformation of education in the context of digitalization and the theory of the competency approach, the latter focusing not only on knowledge, but also on the ability to apply them in real situations (soft skills, transferable skills, 21st-century skills).

Changing the context of education and the labor market under the influence of AI

Given the circumstances of alteration of the economy and education, AI allows us to build competencies that affect the development and career of the future. Modern scientists have described various problems of AI's impact on personnel training (Bingham, 2024; Ramadhona et al., 2022; Kurebay et al., 2023). The authors' research also draws attention to adapting education to new labour market requirements that have been significantly influenced by digitalization (Ramadhona et al., 2022). All these processes have a general impact on transforming education and science. Several scientific studies have shown that AI technologies are changing traditional education and training methods. Intelligent, personalized learning systems affect adaptive learning, which contributes to the effective assimilation of knowledge (Chen et al., 2020; Ciolacu et al., 2018; Ramadhona et al., 2022). Baidoo-Anu et al. (2024) used the ChatGPT Student Experience Scale (SCES) to assess students' views on AI as an education tool. Berendt et al. (2020) identified the principal risks and benefits of using AI in education with a special emphasis on compliance with fundamental human rights. Overall, the study is based on a review of the main challenges. Catchpoole (2022) emphasized the prominence of adhering to ethical standards in modern education. At the same time, scientists noted that AI not only automates routine tasks but also affects the personalization of education and allows for effective monitoring of students' results. A vital change influenced by AI is adaptive learning (Makransky & Lilleholt, 2018). By analyzing large amounts of data, algorithms allow us to determine the individual requirements of each student and offer materials of the appropriate level of complexity. Another notable trend mentioned by the authors is the automation of knowledge assessment (Huang, 2023). The scientific literature shows that AI influences the automation of student work checking

and reduces teachers' workload. At the same time, AI-based systems allow for the analysis of tests, essays, and student responses (Luckin & Cukurova, 2019). This, in turn, affects the provision of quick and objective feedback.

Digital support for competence development and automation of the educational process

According to current research, AI promotes improving skills in many areas, including medicine, finance, engineering, and management (Luckin & Cukurova, 2019). At the same time, the active use of machine learning technologies influences the creation of new professional training models. Jain & Raghuram (2023) noted that integrating AI into the educational process allows the improvement of different skills. Other studies have noted the impact of AI on digital skills and analytical abilities. Such competencies are critical today in the context of rapid automation and changes in the labour market. In addition, studies have shown that AI affects the automation of routine processes and leaves more time for developing strategic thinking and creativity skills (Kumar, 2024; Stolpe & Hallström, 2024). As a result, critical thinking skills are increasing, as students can evaluate proposed options and choose the best solutions (Muraina et al., 2025). Modern authors have conducted separate systematic reviews of AI but did not focus on analyzing the impact of AI on professional development (Xu & Ouyang, 2022; Zhang & Aslan, 2021). However, AI has been shown to improve the educational process, as intelligent systems can automatically adapt curricula and help students with time management. However, despite these benefits, the authors also point to several challenges. They point out that there are several ethical issues and risks of job automation (Sharma & Sharma, 2025). In addition, a notable challenge in different countries is the lack of adequate legal regulation of the use of AI (Sharma & Sharma, 2025). Another significant challenge is training teachers to use AI in the educational process, as not all teachers have the appropriate skills to use AI (Chassignol et al., 2018).

Gaps in the scientific literature

Thus, the analyzed literature shows that AI has a vital role in modern education and affects the development of various skills. Still, the authors also pointed out some problems. This requires revising existing concepts and conducting comprehensive research. In addition, the scientific literature lacks an organised analysis of the role of AI in developing professional skills, as most authors have focused on individual aspects of AI implementation in education. This study will fill in these gaps and provide an analysis of the effectiveness of AI in different educational environments.

Methodology

Research design

The review's objectives were to analyse and deduce the results in light of predefined research topics and criteria that indicate potential future directions. The predefined research focuses were the purpose, subject matter, approach, and results. This review was conducted in 3 stages: critical reading of research papers, their screening, analysis and reporting. This type of research was chosen because of the importance of systematizing the existing knowledge on the use of AI, which is currently lacking in the scientific literature.

Sample and Materials

The source selection is based on purposive criterion sampling. The study envisages using different sources: scientific articles, chapters from monographs, and materials from scientific conferences. The sample is limited to a strict chronological range: from 2018 to 2025. This was done in order to attract the latest and most relevant scientific literature for analysis.

In addition, attention was paid to the credibility of the sources and methodological aspects. Content relevance was also an important criterion. The primary language of publications is English. Table 1 shows the main criteria for including and excluding scientific sources.

Table 1.
Inclusion and exclusion criteria of materials

Criterion	Description
Inclusion criteria	
Chronological framework	Research 2018-2025
Authority of sources	Articles published in peer-reviewed journals or scientific monographs are eligible for inclusion
Methodological quality	Papers of various methodological types are included: review, experimental, meta-analyses, pilot studies, etc.
Contentual relevance	All studies must relate to the using of AI in education
Language of publication	Scientific works written in English
Exclusion criteria	
Outdated sources	Scientific papers written before 2018
Duplicates	All duplicates and works without scientific novelty are excluded
Non-peer-reviewed publications	Popular science articles from blogs, Wikipedia, popular media without scientific confirmation are excluded
Lack of full text	Those works that did not have a full content text were rejected

Source: Authors' compilation

Procedures and Instruments

The PRISMA methodological approach was used to search for scientific literature, screen it, and analyze it. This approach is recognized by modern scholars who consider it relevant for conducting reviews and systematic studies. This systematic review was not registered in PROSPERO or other databases; however, the protocol was developed a priori and followed PRISMA guidelines (Page et al., 2021).

This method was also chosen because it effectively collects new scientific and relevant information. For this purpose, scientometric databases: Crossref, Scopus, Web of Science, and Google Scholar were selected. The search queries included the following keywords: "artificial intelligence", "AI", "technology", "innovations", "professional development", "advanced skills", and "digitalization". A total of 3,291 items were received. After that, all duplicates and articles that did not contain scientific novelty were removed (-1191).

Next, all results that did not correspond to this study's content and thematic part were rejected. This was done by analyzing keywords and titles (-915). Next, the authors examined the results and rejected all publications that did not correspond to the chosen issue (-791). After that, 4 exclusion criteria were used (See Figure 1).

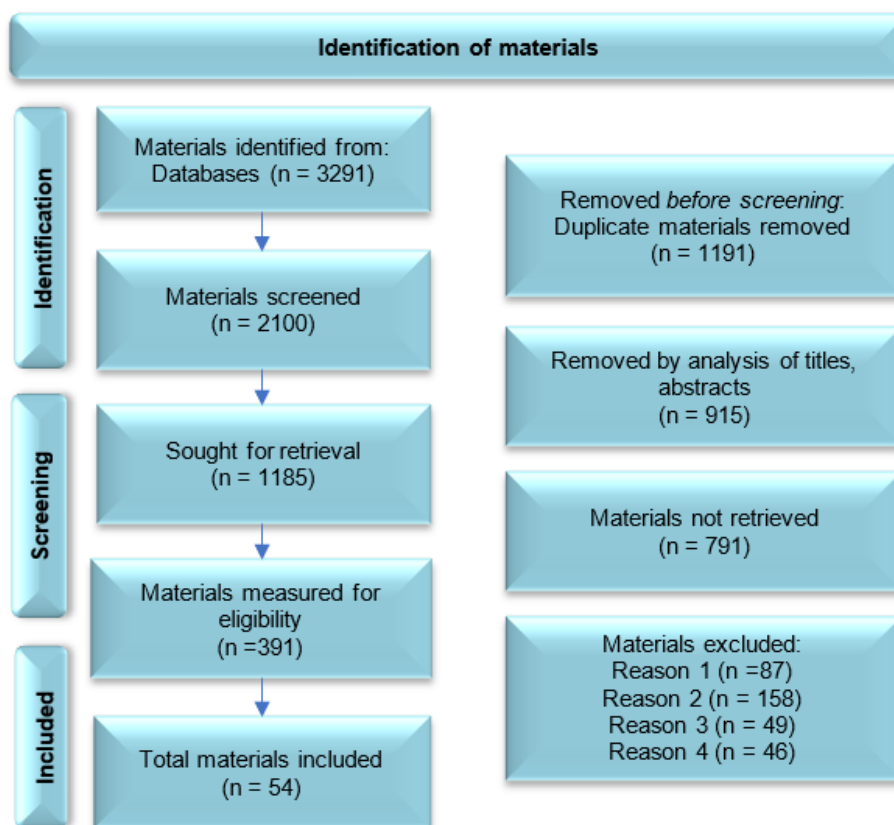


Figure 1. Identification of Materials
Source: Authors' compilation

Data Analysis

The data was analyzed within the Excel program. This software was chosen because of its accuracy and simplicity in organizing data.

Thematic analysis was conducted based on 54 selected sources. Thematic analysis was used for the study, which consisted of several steps. The first step was a thoughtful reading of the collected scientific materials. The second step was the coding process, which consisted of forming the main categories and dividing the overall text into general parts. Primary coding was carried out manually with subsequent use of categorical generalization. The principal content codes defined these parts. At this stage, a deductive approach was used, which involved the use of existing concepts to clearly define concepts: "personalization", "adaptation", "accessibility", "critical thinking" "professional growth". The principal codes are therefore divided into the following parts:

1. Capabilities: "autonomy", "adaptation", "personalization".
2. Skills: "critical thinking", "support for creativity", "flexibility", "interactivity".
3. Challenges: "digital divide", "privacy challenges", "transforming the role of teachers".

The codes were then grouped and combined into broader categories: "main AI opportunities", "impact on professional development", "core challenges". This allowed us to identify the main connections between the themes and characterize key methodological trends. After that, the data obtained was compared with other scientists' data.

To ensure the trustworthiness of the results, two independent researchers performed double coding of 35% of the sample ($n=20$ sources). After comparing the codes, discrepancies were discussed, and the final themes were agreed upon.

To assess inter-coder consistency, Cohen's Kappa coefficient ($\kappa = 0.81$) was calculated, indicating a high degree of consistency.

The coding results were also submitted for review to an external expert in the field of psychological and pedagogical research, which allowed for peer-review of interpretations.

Results

The potential of new teaching methods that influence the formation of competencies that are most needed in the modern challenges is a relevant area of modern academic research on education development. Such competencies in the educational system include design and research, which change the learning process by adding a research and design component. This is the basis for developing critical competencies of future teachers (by the new educational standards) and students (in accordance with the ideas of professional learning).

Specifically, scientists from several disciplines are conducting systematic research on the potential and challenges of artificial intelligence, including individual systems, identifying their capabilities, practical algorithms, and security measures that should be considered when incorporating them into the field of study. According to some researchers, current work on AI is enabling the improvement of large language models (LLMs) (Stolpe & Hallström, 2024). The emphasis has been placed on a completely new digital information source that needs to be integrated into the learning process without destroying the already established basic principles based on the relationship between teachers and students.

Numerous research focused on the potential profits of new technologies, starting with schooling and, as a result, on preparing teachers to structure it creatively (Zhai et al., 2021b). Moreover, the studies positively assess the potential of AI in acquiring the necessary professional competencies, noting some advantages of integrating artificial intelligence into the educational system (Table 2).

Table 2.
Advantages of using AI in the development of professional competencies

No	Opportunities	Description
1	Personalization of education	AI systems allow you to quickly create personalized curricula, consider the previous levels of knowledge and learning style of each student. Personalization contributes to more effective use of educational materials and the formation of individual learning trajectories.
2	Working with large amounts of digital information	Following the modern need to navigate large volumes of information, there is a need to establish work on processing large amounts of information. AI systems allow you to analyze the most effective teaching methods, forecast labour market needs, adjust educational programs, and acquire the necessary professional competencies to adapt to current trends.
3	Development of critical thinking and creative work	Working together with AI systems allows you to find new and rather non-standard solutions, analyze various practices and alternative approaches. Providing such a relevant understanding of the material opens up further opportunities for the active development of analytical skills and creative abilities. In modern market realities, this significantly contributes to professional growth.
4	Automatic execution of routine tasks and saving time	The use of advanced AI systems allows students to engage in more creative and relevant work, freeing up more time for learning and performing much more complex and creative tasks. Such optimization of the educational process provides more opportunities for acquiring the professional skills necessary for training specialists.
5	Organization of monitoring and feedback	Systems that operate using AI can quickly assess the level of mastery of professional knowledge, identify gaps and provide recommendations for their elimination in the future. Such efficiency significantly improves the quality of specialist training.

Source: compiled by the authors based on Morandini et al. (2023); Zhai et al. (2021a); Khudoliy & Voitsekhivska (2015)

In general, AI systems' role in acquiring professional competencies in future specialists is highly relevant. Such integration into the educational process can significantly increase the efficiency of educational activities and adapt them to the critical challenges of our time. It is equally essential that AI can contribute to the training of highly skilled and competitive specialists in the labour market.

The researchers relied on different aspects of AI applications in education (see Table 3). In particular, current research has introduced AI in general education, online education, STEM (STEMA) education, and secondary education. Some areas deal with more specialized learning: computer science, machine learning, and interactive learning.

As for the methodological approach, most of the scientific papers belong to systematic studies (SR), theoretical reviews (TR), pilot studies (PS), narrative reviews (NR), and general reviews (R). However, much less attention is paid to empirical or experimental studies and bibliometric analyses. In addition, in modern works, the authors more often evaluate both the progressive and harmful impact of introducing and using AI in the education system at all levels. Table 3 shows the main directions, methodological approaches, and main results of AI use in the modern educational system.

Table 3.

Characterization of educational directions, approaches, and results in modern research on AI¹

Authors	Learning Subject	Educational level	Approach	Participants	Results
Zhai et al. (2021a)	Education	All levels	SR	-	OUT+
Xu & Ouyang (2022)	STEM education	All levels	SR	-	OUT+
Fidalgo et. al. (2020)	Education Online education	Higher education	EXP PS	Undergraduate students in Portugal, UAE and Ukraine	OUT+
Siraj-Blatchford (2023)	Early education	Early education	TR	-	OUT+/-
Elmahdi et al. (2018)	Technology for Formative Assessment	Higher education	EXP	166 students from university	OUT+/-
Nafea (2018)	Machine learning	Higher education	TR	-	OUT+
Kokku et al. (2018)	Augment traditional teaching	All levels	TR	-	OUT+/-
Zhu et al. (2020)	Online learning Blended learning	Higher education	EXP	94 university students	OUT+/-
de la Torre & Baldeon-Calisto (2024)	Education	Higher education	SR	-	OUT+
Chan & Hu, (2023)	Education	Higher education	EXP	399 undergraduate and postgraduate students	OUT+/-
Chassignol et al. (2018)	Education	All levels	NR	-	OUT+
Zhang & Aslan (2021)	Education	All levels	TR	-	OUT+/-
Dai et al. (2020)	Computer science	Secondary education	EXP	707 students from 17 schools 25 teachers	OUT+
Knox (2020)	Education	All levels	TR	-	OUT+/-
Song & Wang, (2020)	Education	All levels	BA	-	OUT+/-
Joo et al. (2018)	The using of technology	Higher education	EXP	296 participants of the College of Education	OUT+/-

¹ SR stands for Systematic Review, EXP – Experimental Study, PS – Pilot Study, TR – Theoretical Review, NR – Narrative Review, BA – Bibliometric Analysis, and R – Review. Additionally, OUT+/- indicates that the study describes both the positive and negative impacts of technologies.

Webb et al. (2020)	Machine learning	All levels	TR	-	OUT+/-
Winters et al. (2019)	Education	All levels	TR	-	OUT+/-
An et al. (2021)	Online teaching	Higher education	EXP	110 teachers completed the survey	OUT+/-
Zhai et al. (2021b)	Machine learning	All levels	TR	-	OUT+/-
Tuma (2021)	Interactive teaching	All levels	NR	-	OUT+/-
Ramadhona et al. (2022)	Online learning platforms	Secondary education	EXP	Two sample classes of 11-grade science students (38 students), the social science class (25 students). Total - 53 students	OUT+/-
Fahimirad, & Kotamjani (2018)	Teaching and learning	Higher education All levels	R	-	OUT+/-
Fuchs & Aguilos, (2023)	Education	Higher education	EXP	27 students	OUT+/-
Huang et al. (2020)	Education	Higher education	MA	-	OUT+
Khoroshailo, & Kocherhina (2023)	Education Teaching foreign languages	Higher education	TR		OUT+
Baidoo-Anu et al. (2024)	Education	Higher education	EXP	277 students from universities and college	OUT +/-

Source: Author's development

Therefore, this review consists of different approaches, dominated by experimental studies (EXP) and reviews (TR, NR). Experimental studies have been mainly conducted in higher education with student participants, while review studies often cover a broader educational context. Data collection methods in experimental studies include surveys, interviews, observations, while reviews are based on the analysis of previously published materials. Systematic reviews (SR) are used to generalize existing results from different levels of education. Despite the diversity of methods, the results of most studies are positive (OUT+), indicating the effectiveness of the applied technologies and methodologies. At the same time, some studies contain mixed or neutral results (OUT+/-), which may be due to different sample quality or context features.

Hence, 35% of the selected studies reported mostly positive results (OUT+), highlighting the contribution of AI to personalized learning, critical thinking, automation of routine tasks, and improved feedback mechanisms.

65% of the selected papers presented mixed or partial results (OUT+/-). These studies often cited limitations related to technological dependency, limited human interaction, algorithmic bias, and issues of equal access (digital divide).

Thus, the review also made it possible to draw attention not only to the tangible benefits of using AI systems in education. Some educational process risks were also noted, which need to be considered in the subsequent use of intellectual digitalization to form the necessary professional competencies. In particular, essential risks include dependence on technology and decreased human factors. For instance, the increasing role of automated systems in education may lead to a decrease in the role of teachers (Brauner et al., 2025). In addition, there may be a dependence on technology, when excessive trust in AI algorithms will reduce the ability to make independent decisions, critical thinking, and overreliance on AI instead of their analytical work. It is quite paradoxical that AI systems, on the one hand, are aimed at individualizing learning, and on the other hand, contribute to the standardization of knowledge and methods. Excessive use of AI can generate limited approaches to learning that do not develop creativity. In addition, AI algorithms are patented technologies that are kept secret. Potential biases or unrepresentative data may hurt the objectivity of assessments or pedagogical recommendations

(Sharma & Sharma, 2025). In addition, the imperfection of algorithmic solutions is a significant challenge. However, a significant problem in the modern learning space is the digital divide between students and teachers, which needs to be addressed urgently. Implementing AI-based solutions for the acquisition of professional competencies is a rather expensive process. This problem may become noticeable in the global dimension, when access to quality education in less affluent regions is limited. (Table 4).

Table 4.

Risks of using AI systems in the acquisition of professional competencies

Nº	Risks	Description
1	Increased dependence on technology, weakening of the human factor in contacts	May lead to a decrease in the role of teachers. This will destruction the development of interpersonal skills among students (Brauner et al., 2025). In addition, there may be a dependence on technology.
2	Uniformity of training and bias of AI algorithms	Artificial intelligence contributes to the standardization of knowledge and approaches. Its excessive use can limit the development of creativity (Hryhorak et al., 2023). In addition, AI algorithms are closed patented technologies, which can lead to bias and biased educational recommendations.
3	Accessibility and digital divide	Implementing AI-based solutions for the acquisition of professional competencies is a rather expensive process. (Sharma & Sharma, 2025). The existence of a digital divide will not help access to education.

Source: Author's development

Along with the inevitable emphasis on the advantages and disadvantages of the application, it is essential to consider those aspects that are still poorly assessed in the scientific literature. In particular, the use of AI in education and forming professional competencies has been studied fragmentarily. First, the existing works emphasize the theoretical foundations of AI in education. At the same time, empirical calculations, individual experiments, and long-term studies of AI (including the impact on professional skills development) are pretty rare. Scientists pay little attention to the cross-disciplinary approach to the use of AI, particularly in combining technological, psychological, and pedagogical knowledge. A separate problem is the lack of established approaches to assessing the effectiveness of AI in creating professional competencies, including the process of individualizing learning.

Based on this, it is possible to formulate specific research recommendations that could be used for further study of this issue. First, further integration of AI systems into educational programs can be identified as an important area: the use of adaptive platforms or virtual assistants in training. The process of teachers acquiring additional digital competencies to enable them to use AI efficiently will require a separate assessment. Special training and seminars would allow us to rethink certain features of the training of modern teachers, which is an important area for future research. There is also a need to study potential adjustments that need to be made to train students to improve their professional competencies.

Discussion

The research of the function of AI systems in modern education is a highly relevant issue, given the potential for such digitalisation in the future. The purpose of the proposed research is to conduct a review of AI in forming professional competencies of the future and to analyse its impact on the education system in general. As a result, it is envisaged to find answers to the primary research tasks, in particular, to analyse current publications on the impact of AI and identify its positive role on the progress of professional competencies.

The proposed results note that an essential aspect of research is to determine the potential of new teaching methods that would create the competencies that are most needed in the context of modern challenges, especially considering current problems with education development. Such competencies in the educational system include design and research, which change the learning process by adding a research

and design component. The results obtained indicated that one of the key areas of influence of AI is the development of critical thinking, creativity, and problem-solving skills, which are identified by international structures (WEF) as the most in demand in the 21st century.

Current work on AI enables the improvement of large-scale language models that validate incredible capabilities in various fields. This poses a significant challenge to the traditional understanding of learning or cognition. Many studies have focused specifically on exploring the potential benefits of new technologies, starting with schooling and, as a result, on preparing teachers to structure it creatively. In general, the potential of AI systems to acquire professional competencies required by the labour market was positively assessed. Among the most obvious advantages are the personalisation of education, the ability to procedure large amounts of digital information, the active development of critical thinking and creativity, autonomous and accelerated performance of routine tasks, and high-quality monitoring of the educational process and feedback. Other researchers also identify the same benefits but arrange them in different sequences according to their theoretical concepts or empirical calculations (Bingham, 2024; Luckin & Cukurova, 2019). Time is now highlighting opportunities for the development of critical thinking and creativity in students, which directly contributes to the further improvement of professional competencies (Rodríguez Illera, 2024; Sijing & Lan, 2018; Turchyn et al., 2023). Less attention is paid to such an option as self-education. Only a few researchers emphasise this aspect, pointing out that education in the modern world is also based on acquiring informal knowledge, which can also be obtained through AI systems (Yi et al., 2024).

The proposed results show that the function of AI systems in the acquisition of professional competencies by specialists of the future is highly relevant. Therefore, the analysis of scientific literature also made it possible to draw attention not only to the tangible benefits of using AI systems in education. The most immediate risks of using AI systems to acquire professional competencies are the growing dependence on technology, the bias of AI algorithms, the digital divide, and the problem of technology accessibility. The findings confirm other scholars' conclusions that specific challenges need to be addressed in the next work on the impact of AI on the educational process (Catchpoole, 2022; Kumar, 2024; Omelchuk et al., 2022). The proposed results also note that most scientific studies openly note AI's advantages and disadvantages. Other scholars also emphasise this feature (Chen et al., 2020; Muraina et al., 2025). While the use of AI allows for individualisation of the educational process and the formation of individual learning trajectories, the fascination with AI technologies and their excessive use, on the contrary, makes learning typical and inflexible and causes certain forms of dependence on students. We should agree with researchers who point out the meaning of finding a balance in the use of modern technologies (Huang, 2023). Excessive use of AI systems does not contribute to developing professional competencies in education.

The analysis has revealed that certain aspects are still poorly assessed in the scientific literature: the lack of empirical calculations, the lack of attention to the cross-disciplinary approach to the use of AI, and the lack of established approaches to assessing the effectiveness of AI in creating professional competencies. Hence this article identified different gaps in scientific literature. In particular, the weak treatment of the topic of self-education as an important channel for acquiring professional skills through AI systems. Despite the popularity of the concept of lifelong learning, only a few authors (Yi et al., 2024; Guerrero-Quíñonez et al., 2023) pay attention to non-formal and informal forms of learning that are implemented thanks to digital technologies. Another underestimated area is the interdisciplinary approach to studying AI in education. Most scientific works remain within the framework of pedagogy or IT sciences, while the effective integration of AI requires considering legal, social, psychological and ethical factors (Sharma & Sharma, 2025; Gutierrez et al., 2022).

Recommendations for further research directions include the study of the integration of AI systems into educational programmes, the process of teachers acquiring additional digital competencies, and potential adjustments to be made to the training of students to improve their professional competencies (Ciolacu et al., 2018; Salas-Pilco & Yang, 2022). In particular, this statement is relevant to the importance



of conducting comprehensive research and systematic analysis to determine further advantages and disadvantages of using AI to acquire professional competencies.

The results in the paper, even though they do not lessen the significance of the findings.

Conclusions

A systematic analysis of 54 studies of AI systems' impact on professional competencies development has demonstrated the advantages, disadvantages, difficulties, and prospects for further research on this issue and the general use of AI in the educational process. Among the reviewed studies 39% were experimental studies (EXP), mostly conducted in higher education institutions with the participation of students; 36% were theoretical reviews (TR). Other methodological approaches included systematic reviews (SR) – 7%, descriptive reviews (NR) – 7%, general reviews (R) – 3%, meta-analyses (MA) – 3%, bibliometric analyses (BA) – 3%. This has led to a dominance of theoretical studies over empirical or data-driven studies. Theoretical studies (TR, SR, NR, R, BA, MA) make up $\approx 62.96\%$. At the same time, experimental studies (EXP, PS) account for $\approx 37.04\%$. Hence, only about 2 in 5 studies presented detailed quantitative data or robust long-term results on the impact of AI on competency development. However, 35% of studies reported predominantly positive results (OUT+) and emphasized the position of AI in personalized learning, automation of routine tasks, and improved feedback mechanisms. At the same time, 65% presented mixed or partial results (OUT+/-). These studies often cited limitations related to technological dependency, limited human interaction, algorithmic bias, and issues of equal access (digital divide).

These results indicate the high potential of AI in individualizing learning, automating assessment, developing critical thinking and analytical skills. At the same time, the presence of mixed or partially positive results (65% of studies) suggests that the effectiveness of AI largely depends on the context of application, the quality of the digital infrastructure and the digital skills of teachers and students.

The originality of the review lies in the synthesis of qualitative analysis of the content of studies with a quantitative assessment of the types of methodologies and results. This approach made it possible to demonstrate the structural disproportion between theoretical and empirical studies. In addition, the study also revealed a lack of experimental data, which narrows the possibilities of forming educational policies based on evidence.

There are several limitations on this study. Priority one should be given to PRISMA's scientific methodology, which includes choosing and categorizing pertinent scientific sources. This does not rule out the possibility that the systematic review may have overlooked some important previous articles. These factors must be taken into account while evaluating? (what?). Certain limitations open up new directions for research. In particular, future work should develop tools to measure the effectiveness of AI in the formation of professional competencies. Special attention should be paid to empirical verification of the use of an interdisciplinary approach to assess the role of AI in education (with the involvement of pedagogy, psychology, ethics, IT industry). Finally, an important direction is to determine the type of digital competence of teachers based on the analysis of individual advanced training programs.

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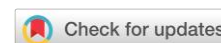


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DOI: <https://doi.org/10.46502/issn.1856-7576/2025.19.02.20>

Cómo citar:

Zamsha, A., Dushka, A., Omelchenko, I., & Kobylchenko, V. (2025). Motivational aspects of bullying of children with special needs in the educational process. *Revista Eduweb*, 19(2), 296-311. <https://doi.org/10.46502/issn.1856-7576/2025.19.02.20>

Motivational aspects of bullying of children with special needs in the educational process

Aspectos motivacionales del acoso a niños con necesidades especiales en el proceso educativo

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Recibido: 07/05/25

Aceptado: 20/06/25

Abstract

This study examines the key motivational factors that lead to bullying against children with special educational needs in both inclusive and special educational environments. The present study empirically examines the motivational aspects of bullying. The research employed a structured survey involving 40 participants with relevant experience in inclusive education: teachers, psychologists, school administrators, and parents of children with special educational needs. The thematic analysis method was used to analysis the data. The analysis revealed that aggressive behaviour in school settings is often shaped by external social influences, particularly peer dynamics and exposure to digital media. Additional contributing factors include psychological maladjustment among perpetrators and inadequate responses from adults in educational contexts. Victimization is frequently associated with the limited self-defence capacity and social integration challenges faced by students with special needs. The study found no significant difference in the prevalence of bullying across educational



models, suggesting that school culture and institutional support are more influential than the type of classroom setting. Effective prevention requires systematic communication among stakeholders and the early identification of bullying behaviours by trained professionals. The findings underscore the necessity of addressing the underlying motivations behind bullying in order to design sustainable intervention strategies. Hence, they are important for improving school policies and teacher training programs, as they contribute to the formation of a safer and more inclusive educational environment for children with special educational needs.

Keywords: bullying motivation, special education, inclusive education, children with special educational needs, family and school prevention.

Resumen

Este estudio examina los principales factores motivacionales que conducen al acoso escolar contra niños con necesidades educativas especiales, tanto en entornos educativos inclusivos como especializados. La investigación empleó una encuesta estructurada en la que participaron 40 personas con experiencia relevante en educación inclusiva. El análisis reveló que el comportamiento agresivo en el entorno escolar suele estar condicionado por influencias sociales externas, en particular la dinámica entre compañeros y la exposición a los medios digitales. Otros factores que contribuyen a este fenómeno son la inadecuación psicológica de los agresores y las respuestas inadecuadas de los adultos en el contexto educativo. La victimización se asocia frecuentemente con la limitada capacidad de autodefensa y los retos de integración social a los que se enfrentan los alumnos con necesidades especiales. El estudio no encontró diferencias significativas en la prevalencia del acoso escolar entre los distintos modelos educativos, lo que sugiere que la cultura escolar y el apoyo institucional son más influyentes que el tipo de entorno escolar. Para una prevención eficaz es necesaria una comunicación sistemática entre las partes interesadas y la identificación temprana de los comportamientos de acoso por parte de profesionales cualificados. Los resultados subrayan la necesidad de abordar las motivaciones subyacentes al acoso escolar para diseñar estrategias de intervención sostenibles.

Palabras clave: motivación del acoso escolar, educación especial, educación inclusiva, niños con necesidades educativas especiales, prevención familiar y escolar.

Introduction

Inclusive education, which is actively developing in the modern world as a separate pedagogical trend, involves providing education to children with special educational needs, including through joint learning with their peers in regular general education institutions. This approach is a common practice and an optimal step towards the humanization of society and the implementation of the principles of equal access to educational services. At the same time, along with the quite objective positive consequences of using this approach, such changes are accompanied by several challenges that must be overcome. One of the most common challenges is the problem of bullying, i.e., targeted, systematic harassment that manifests itself in psychological, physical or social influence (Filipenko et al., 2022; Kondratyuk et al., 2025). This challenge has become most acute in connection with the need to integrate children with special educational needs into normal society, as they are most vulnerable to discrimination, various kinds of stigmatization and negative social influence (Dovhopola et al., 2024). According to a number of international studies, children with special educational needs are 2–3 times more likely to be bullied than their peers without such needs. This indicates the critical vulnerability of this group (Fissel & Bryson, 2024). In addition, in the context of the Ukrainian education system, according to empirical research, more than 40% of parents of children with special needs report cases of social exclusion or aggressive behavior by peers (Byrko et al., 2022). This indicates the importance of analyzing the motivations of the aggressor. Moreover, according to some estimates, children with special needs are more likely to become victims of school bullying than their peers (Kapitanoff & Pandey, 2024). First, this situation is due to their behavioral characteristics, needs, and possible external manifestations of their health condition. However, more often than not, the reason is more prosaic: the lack of readiness of the educational environment (peers, teachers, and school administrators) to accept their differences. Conversely, an important gap in the current research literature is that researchers primarily focus on the practical field of bullying prevention (including victim protection mechanisms). At the same time, a deeper study of the motivation of perpetrators often does not



become the subject of special scientific attention. The relevance of the scientific study of the motivational aspects of bullying is due to the need to understand the internal motivations and complex value orientations, individual social attitudes and psychological needs of those who initiate, carry out or join the bullying. The study of such mechanisms will allow not only the formulation of certain preventive measures but also the creation of a healthy microclimate in the school community in the future to adhere to the mood of empathy, social responsibility and tolerance among all participants in the educational process.

The purpose of the study is to analyze the main motivational factors that contribute to bullying among children with special needs in inclusive and special education and to develop specific recommendations for preventing and correcting this phenomenon. This goal involves the following tasks:

1. What are the social and psychological factors that stimulate bullying among children with special needs?
2. What are the differences in the motivational factors of bullying in inclusive and special education?
3. What practical strategies and pedagogical interventions can prevent bullying in educational institutions?

Literature Review

The issue of bullying in the modern educational environment has become a subject of active research discussion in contemporary pedagogy, psychology, and sociology. In particular, bullying is now understood as aggressive and often repeated, systematic behavior aimed at humiliating another person, dominating them and their feelings, and isolating them from other members of the team. Such cases often occur among children or adolescents, including within school groups. A classic and well-researched study demonstrated the existence of a solid theoretical basis for understanding and further studying this phenomenon (Thornberg et al., 2012). Defining the role of teachers and school administrators in preventing bullying (Liu et al., 2024) and analyzing the tangible long-term consequences that are important for the mental health of victims.

Much attention in modern scientific sources is focused on identifying and analyzing manifestations of bullying committed against children with special educational needs. This category of schoolchildren is the most vulnerable group, as they often have psychophysical characteristics, social stigma, or limited opportunities for self-defense. According to research, students with developmental disabilities, including those with various manifestations of the autism spectrum, language skills, intellectual development, or any other physical disabilities, are much more likely to become victims of systemic bullying by their peers (Hartley et al., 2015; Berchiatti et al., 2022). For example, international measurements have made it possible to confirm that the statement of compliance with inclusion norms in the school environment does not automatically guarantee that it will be implemented qualitatively (Berchiatti et al., 2020), especially without proper psychological and pedagogical support. The research emphasizes that the manifestations of aggressive students' social or psychological behavior are extremely important for effective counteraction to school bullying (Fissel & Bryson, 2024). First, such manifestations of negative behavior as unmet need for recognition, need for social comparison, frustration, lack of empathy, need to assert themselves at the expense of others, etc., were noted. Important aspects are manifestations, such as the reproduction of behavioral models projected by the family environment or external models (social networks, media, movies, etc.). In this context, the emergence of bullying in the educational process often acts as a reaction to the inability of children or adolescents to properly adapt to social norms or to the otherness of other students (to perceive it properly).

For example, bullying could often be a way to assert one's social status in the school community or another social group, a demonstration of strength or other influence, a means of transferring negative emotions, or even a consequence of a lack of knowledge about the norms of social communication. The study of children with special educational needs noted that their difference is sometimes perceived as a weakness or belonging to a "different nature" (Malisiova & Folia, 2024). This creates conflicts and provokes aggression



in those students who themselves have several internal complex psychological problems, lack attention or experience an extreme lack of emotional support. In the Ukrainian scientific context, the problem of bullying has been considered mainly from the standpoint of counteracting bullying and legal regulation (Chabursky et al., 2024; Moroz et al., 2023).

Moreover, Cabrera et al. (2022) compared traditional bullying and cyberbullying in rural and urban schools (Castilla-La Mancha, Spain). The authors used a survey method and interviewed students from urban and rural schools. Accordingly, the authors indicated that the frequency of roles in bullying (victims, aggressors, bullies/victims) is the same in urban and rural schools. However, physical bullying and victimization are more common in urban schools.

Gimenez et al. (2024) indicated the relationship between victimization of bullying and academic performance. In particular, they processed data from students from different countries and indicated that, as a rule, victims of bullying demonstrate low results in mathematics, reading and natural sciences.

Zapata-López et al. (2024) indicated the relationship between physical inactivity (sedentary lifestyle) and bullying among adolescents in Colombia. Accordingly, the authors' results showed that there is a connection between a sedentary lifestyle and a higher probability of becoming a victim of bullying. Accordingly, this indicates that there is a correspondence between a healthy lifestyle and the detection of bullying.

At the same time, Sarancha et al. (2022) identified the existence of mutual supportive parental support and socialization of children with special needs in rehabilitation centers. Accordingly, the study indicated that mutual emotional and methodological support of parents improves the socialization of their children and promotes the development of empathy.

The emphasis in such studies is on the formation of safe, educational environments, the creation of separate anti-bullying programs, and increasing the levels of psychological competence of teachers and school administrators. In addition, the research works of Ukrainian researchers usually focus on the needs for the socialization of children with special needs, the creation of appropriate tolerant environments in general classes, or the formation of inclusive classrooms. Such research works primarily focus on the mechanisms of adaptation of children with special needs to study and continue their studies at universities. The psychological aspects of bullying are often on the margins of such research. However, some studies that focus exclusively on the motivational aspects of bullying against children with special educational needs are still relatively few (Byrko et al., 2022). In particular, in the modern scientific discourse there are few works that deal with the empirical verification of the state of the problem of bullying. This situation creates prerequisites for a broader disclosure of the issues proposed in the article, which ultimately led to the scientific novelty of the proposed study.

Thus, the study of the current state of scientific research on the proposed topic indicates the need to form both a theoretical and empirical basis in the field of general analysis of the issues of bullying and inclusion. It is worth noting that the motivational component of such bullying in inclusive educational environments will require a deeper study, which has determined the main direction of further research.

Methodology

The present study empirically examines the motivational aspects of bullying of children with special educational needs in the modern educational environment. The basis for collecting empirical material was a survey of people directly involved in inclusive and special education, including teachers, psychologists, school administrators, and parents of children with special educational needs. This approach made it possible to identify the underlying motives, social and psychological preconditions, and barriers to preventing bullying against children.

Sample

The purposive sampling method was used to implement the proposed study. This method made it possible to involve respondents with relevant experience working with children with special educational needs. A total of 40 respondents from the above categories participated in the survey. At the same time, special criteria for inclusion in the sample were used (see Table 1).

Table 1.
Criteria for including respondents in the survey

No	Criterion	Description
1	Experience	To participate in the survey, candidates were considered who had experience working or raising children with special educational needs for at least 3 years.
2	Inclusivity	Availability of the necessary level of knowledge (or performance of professional tasks) in the field of inclusive education in Ukraine.
3	Technological Capability	Availability of technical capabilities to complete the survey within the specified period (January-February 2025)
4	Voluntariness	Providing voluntary consent to participate in the survey, which was confirmed in the appropriate manner.

This sample size is optimal for a qualitative study, the purpose of which is to identify typical behavioral patterns, motivational factors, and contextual features, rather than to form statistical generalizations.

The number of 40 people allowed to ensure professional and functional diversity of respondents (teachers, psychologists, administration, parents of children with special needs) and at the same time to maintain analytical depth when conducting thematic analysis. According to recommendations in the field of qualitative research, a sample of this size is sufficient to achieve data saturation - the moment when new interviews do not add new significant themes or categories. This indicates sufficient completeness and representativeness within the framework of a qualitative approach.

Thus, the sample size of 40 people provides a balance between the variability of responses and the possibility of their analysis.

Data collection procedure

The collection of empirical data took place in several important stages. First of all, it was important to collect permission from the administrations of educational institutions to conduct a socio-psychological study with the participation of employees. The survey was supposed to be conducted in person or remotely, lasting up to 45 minutes. A semi-structured questionnaire was developed to collect data, containing 10 open-ended questions grouped into four thematic blocks:

- Prevalence and perception of bullying in inclusive education.
- Motivational factors of bullying behavior.
- Features of the school environment and inclusive interaction.
- Strategies for preventing and responding to bullying.

The questions were as follows:

- In your opinion, why do children with SEN most often become the object of bullying?
- What do you think are the social or psychological factors that most influence the occurrence of bullying against children with SEN?
- What practices do you consider effective in preventing aggression in an inclusive classroom?

- What do you think are the most common reasons or motives that encourage children to bully in an inclusive environment?
- What measures do you think are most effective in preventing bullying in the school environment?
- What practices have you used or observed in your professional activities to overcome bullying?
- What prevents an effective response to bullying in educational institutions?
- What are the main difficulties, in your opinion, that prevent teachers, administrations or parents from combating bullying?
- How important is staff training in dealing with bullying?
- What changes would you suggest to reduce the level of bullying against children with special needs in schools?

The survey was conducted in person or remotely, depending on the capabilities and wishes of the respondents. The average duration of participation was 45 minutes. Before the start of the study, official permissions were obtained from the administrations of educational institutions to conduct a socio-psychological survey among employees and parents. The survey was conducted from December 2024 to January 2025 in three inclusive educational institutions located in Kyiv and Poltava.

Data analysis

The thematic analysis method was used to further work with the collected material. The thematic analysis, was carried out in six stages:

- Getting acquainted with the data (transcription, rereading).
- Initial coding using open coding.
- Formation of themes through axial coding.
- Verification and generalization of themes.
- Description and naming of key themes.
- Formation of conclusions.

After transcribing the text, key themes repeated in the responses were identified: motivational factors of aggressive behavior, the role of the school environment, practices for preventing and responding to bullying, and barriers to implementing inclusive approaches. The data obtained were manually codified due to the conscious use of open and axial coding.

The selected categories included, in particular:

- Motivational factors of aggressive behavior;
- Barriers to inclusion in the educational environment;
- Successful bullying prevention strategies;
- The role of the school and the team in supporting children with SEN.

To increase the reliability of the analysis, the transcripts were checked by two independent researchers, after which the final structure of the categories was agreed.

After transcribing the interviews and discussing them, key themes repeated in the responses were identified: motivational factors of aggressive behavior, the role of the school environment, practices for preventing and responding to bullying, and barriers to implementing inclusive approaches. The data obtained were manually codified due to the conscious use of open and axial coding. Individual recurring patterns and content blocks were summarized into categories, which were then interpreted based on the needs of conducting the study and solving the proposed research questions. To increase the reliability and validity of the analysis, all transcripts were analyzed by two independent researchers. Each researcher conducted the open and axial coding stages separately, after which the codes and themes were compared and discussed, which allowed to eliminate subjective interpretations and achieve a consistent category



structure. In cases of disagreement, additional verification of the primary sources (interview texts) was carried out to ensure that the codes corresponded to the context of the responses.

This approach allowed to ensure transparency of the procedure, tracing the analytical process (from the statements of the participants to the conclusions)

Ethical aspects of the study

The principles of compliance with all modern ethical standards were laid at the heart of the study. Participants completed an appropriate questionnaire, thanks to which the inclusion criteria were applied to the number of respondents. Later, they filled out the appropriate informed consent (before the survey began). All respondents were guaranteed anonymity (personal data, names or place of work are not subject to publication). Everyone was guaranteed the right to refuse to participate in the experiment at any stage of its conduct, with the ability to completely delete previously provided information. The data obtained are stored in a protected environment and used exclusively for research.

Results and Discussion

The relevance of analyzing the motivational aspects of bullying against children with special educational needs is due to the need to better understand the socio-psychological factors that cause aggressive behavior in the school environment. Despite the active use of inclusive education, bullying is quite common, which can significantly complicate the process of socialization and education of children (Murillo-Moraño et al., 2024). The peculiarity of the study is that it aims to identify the opinions and experiences of teachers, psychologists and parents about the causes, forms and mechanisms of bullying, as well as to identify effective pedagogical interventions to counteract such phenomena. First, the socio-psychological factors of bullying against children with special needs were noted. In particular, during the analysis of the responses of 40 respondents (teachers, psychologists, parents of children with special educational needs), several main factors contributing to the emergence of bullying were identified. In particular, borrowing models of aggressive behavior from the social environment became important. According to the responses, one of the main causes of bullying is the influence of external models of behavior that children adopt in informal school groups, among friends, as well as from social networks and the media. Such influence forms aggressive patterns, which are then embodied in the bullying of children with special educational needs. A school psychologist with 8 years of work experience said: "Children often copy what they see on social networks or among friends, where aggression has become the norm. This also gets into the school environment, especially towards children who are different." The second important factor is the psychological problems of the bullies themselves — a feeling of insecurity, fear of social rejection, the need to assert themselves. Bullies often use aggression as a means of confirming their status in the team. Teacher 3 indicated: "Some children who bully feel isolated themselves, and therefore try to show their strength to others." Respondents also noted that the lack of appropriate response or intervention from adults (parents, teachers, administration) increases the aggressive behavior of bullies. The school administrator indicated that "Bullies often feel impunity because they do not see the consequences of their actions due to the passivity of adults." Other important factors were the low ability of children with SEN to protect themselves. In addition, the lack of support from peers and problems in establishing friendships contribute to the isolation of children and increase their risk of bullying.



Table 2.
Factors of bullying against children with special needs

Topic (Factor)	Code	Example quote
Borrowing aggressive behavior patterns	Influence of social environment	School Psychologist 2: "Children copy behavior from social media and friends, where aggression has become the norm."
Psychological difficulties in the adaptation of bullies	Insecurity, need for self-affirmation	Teacher 4 "Aggression is a way to show strength when a child feels insecure."
Feeling of impunity	Adult passivity towards bullying	Administrator 2 "Bullies feel impunity because of the lack of reaction from teachers and parents."
Low ability to self-defense in children with OOP	Vulnerability, inability to defend oneself	Inclusive classroom teacher 1 Children who cannot stand up for themselves become easy victims.
Difficulties in social adaptation	Lack of friends and support	Parent 8 "The lack of friends increases the risk of bullying."

Source: author's development

The most dangerous factors that contribute to aggressive behavior of bullies can be identified as borrowing behavioral models from third-party resources. First of all, we are talking about informal school groups or the destructive influence of social networks that form aggressive behavioral patterns towards children with special educational needs. The survey also found that bullies often have psychological difficulties adapting to school groups and therefore need to assert themselves, sometimes by humiliating others.

At the same time, the survey asked respondents to identify the behavioral characteristics of students with special educational needs that lead to bullying (see Figure 2).

The findings indicate that the formation of bullying against children with special needs can be equally formed in any form of education. 23 respondents (56% of all respondents) gave this assessment. This response is also confirmed by the fact that other respondents could not convincingly identify which education system has a higher risk of bullying (8 and 7 respondents, respectively, for inclusive and remedial education). Bullying is equally widespread, as it probably depends more on the environment of students, teachers, and administrators than on the form of education. The motivational reasons for bullying in inclusive classes and special educational institutions may differ (Table 3).

Table 3.
Motivational reasons for bullying in inclusive classes and special institutions

Nº	Reason	Practical quotes
1	In inclusive classrooms, bullying is often caused by students' lack of awareness of the specifics of the development and behavior of children with special educational needs	Teacher 12: Children don't always understand why an inclusive student reacts differently or takes longer to complete a task. Parent 2: My son is in an inclusive class, and I see how other children can be insulting to him because they don't understand why he needs an assistant.
2	For special institutions, the emergence of bullying is mainly based on the background of deepening internal competition between children with similar disorders	Administrator 2: We have children with the same or similar diagnoses, and this sometimes creates competition for the teacher's attention or for leadership in the group. Psychologist 4: There is an internal hierarchy: who speaks better, who writes better — and this can develop into rivalry, accompanied by bullying.

3	In special educational institutions, the motivation for the emergence of bullying is the probable desire to dominate all those who are "weaker" or "different".	Teacher 14: Sometimes children who have better socialization skills begin to look down on those who are quiet or have other difficulties Parent 3: Everyone wants to be 'the boss' - even if they have problems themselves, they may make fun of those they think are 'weaker'
4	In an inclusive environment, bullying may be associated with the presence of certain social stereotypes that are developed in families or cultivated through various media channels.	Teacher 9: Often, a child repeats what they hear at home: that children with special needs are 'not like that' Parent 7: The media and parents sometimes give children the idea that a special child is a 'not-so-good' student.
5	In both inclusive classrooms and special institutions, the motivations for the emergence of bullying are similar, but its level may be different due to the existence of different contexts of the development of the school community and the characteristics of staff training.	Administrator 4: The mechanisms are similar — the need for self-affirmation, family influence, but the level of conflicts depends very much on the preparedness of the staff. Teacher 6: Even if the reasons are similar, an inclusive classroom with a trained teacher performs better than a specialized school without systemic support.

Source: author's elaboration

The respondents, continuing the previous trend, determined that bullying is equally possible in both inclusive classes and special educational institutions and that the motivation for its occurrence is the characteristics of the local school community and the level of training of teachers and administrators. At the same time, also respondents also believe that in an inclusive environment, there are more threats due to unfavorable upbringing or negative media channels than in special educational institutions. Other variants of the emergence and spread of bullying generally received approximately identical scores.

The respondents were also asked to identify specific practices and interventions that would prevent the spread of bullying in the school environment, including against children with special needs. According to the respondents, the survey focused on the most effective strategies for preventing bullying (see Table 4).

Table 4.

Coding matrix of practical bullying prevention strategies: interventions, codes and participant quotes

Strategy / Intervention	Code category	Quotes
Strengthening communication between teachers, parents and administration	Strengthening communication	Teacher 13: "Regular dialogue between all participants in the educational process helps to notice and stop bullying in time."
Training teachers and psychologists to identify bullying at an early stage	Early detection training	Administrator 3: "Teachers should clearly understand how to notice early signs of bullying and have an algorithm of actions."
Training for students aimed at developing empathy and tolerance	Empathy and tolerance development	Teacher 9: "It is necessary to develop empathy, talk to children about differences and teach them not to be indifferent."
Group classes aimed at improving the adaptation of children with special needs	Adaptation of children with SEN	Psychologist 1: "Extracurricular work, joint games or projects are a chance for children with special needs to better integrate into the classroom team."
Introducing stricter sanctions for bullies	Not specified (critical rating)	Psychologist 4: "Punishment is not always the solution. Often it only increases resistance, rather than changing behavior."

Source: author's elaboration

Respondents noted that strengthening communication and information exchange among teachers, parents, and school administrators is important to counter bullying. At the same time, the importance of training teachers and school psychologists to identify bullying at the early stages of its occurrence was also emphasized. It is also worth noting the high appreciation of special training for schoolchildren that would develop empathy and tolerance, emphasizing the possible negative impact of social media, the Internet in general, family relationships, etc. Other strategy options are less popular, although measures to improve the adaptation of children with special educational needs can also be justified additions to existing practices. As for the effectiveness of toughening the punishment of bullies, the effectiveness of this approach is debatable. Respondents also identified some difficulties in preventing bullying among children with special educational needs (see Table 5).

Table 5.

Coding matrix: from quotes to generalized categories (example of axial coding)

Open coding (quotes/ideas)	Axial coding	Code
"We are constantly being forced to do some tests, papers, and the children are left alone." Teachers: 2, 5, 8	Teacher overload	Overload of school staff
"Not all teachers know how to detect bullying or work with the aggressor." Teachers: 9, 10	Low professional training	Need for teacher training
"Bullying of children with special needs does not always fall under clear legal categories, and this is a problem." Teachers: 19, 22	Insufficient legal protection	Weak legal protection for children with SEN
"Children do not know what bullying is - they think it is just a joke." Teachers: 24	Insufficient awareness	Low awareness among students
"If there is no teamwork - there will be no result. One teacher will not change the system." Teachers: 21	Lack of cooperation between parents and school	Lack of systemic cooperation

Source: author's elaboration

Thus, the respondents identified the problem of being overloaded with outside tasks as a major obstacle to combating bullying in school teams. Respondents also noted the need to improve the level of training of teaching staff. Insufficient legal protection of children with special needs, low awareness of the problem among schoolchildren, and lack of systematic work by parents and school administrators were recognized as less significant phenomena. Identifying these factors allows us to consider them in the future when planning measures to prevent bullying in schools.

Bullying against children with special educational needs is a complex problem that requires detailed consideration. The proposed purpose of this study was to analyze the main motivational factors that contribute to bullying among children with special needs in inclusive and special education and to develop specific recommendations for preventing and correcting this phenomenon. In order to fulfill this main task, it was decided to consider more specific issues, in particular, the identification of socio-psychological factors that stimulate the occurrence of bullying among children with special needs, the characteristics of differences in the motivational factors of bullying observed in inclusive and special education, and the recommendation of practical strategies and pedagogical interventions that can be effective in preventing bullying in educational institutions. Considering the most dangerous factors that contribute to the aggressive behavior of bullies, several destructive elements were identified, including the borrowing of behavioral models from third-party resources (informal school groups or the destructive influence of social networks that form aggressive behavioral patterns towards children with special educational needs). The presence of psychological difficulties of bullies with adaptation in school groups and impunity, which is the result of the inaction of parents or teachers, were identified as less dangerous. On the other hand, children with special educational needs are identified as victims of bullying due to their low capacity for self-defense and problems with social adaptation.

The results obtained confirm previous study by Afuzova et al. (2022) on the complexity of the phenomenon of bullying in inclusive education. However, our study not only confirms, but also clarifies specific socio-psychological mechanisms, in particular through the prism of the professional experience of various participants in the educational process.

At the same time, researchers also note that children with special needs are targeted by bullies because of their low ability to defend themselves, including due to a lack of social contact with other students (which prevents them from being perceived as “their own”) (Kocaj et al., 2018; Horton et al., 2025). Identifying such motivating factors for bullying will help to overcome such situations in the future (Bilavych et al., 2022). The proposed results show that bullying of children with special needs is equally likely to occur in any form of education (inclusive and remedial). This prevalence depends more on the environment of students, teachers, and administrators than on the form of education. Continuing the previous trend, respondents identified that bullying is equally likely to occur in inclusive classes and special educational institutions, and that it is motivated by the characteristics of the local school community and the level of training of teachers and administrators. However, many respondents also believe that in an inclusive environment, there are more threats due to unfavorable education or negative media channels than in educational institutions.

One of the most important conclusions is that bullying is not the prerogative of only general or specialized educational institutions. At first glance, respondents tend to conclude that bullying is equally prevalent in all types of educational institutions. However, this position requires careful interpretation: such answers may not indicate a real equal frequency, but an awareness of the systemic nature of the problem (Menéndez Santurio et al., 2020; Popel et al., 2023). In this sense, it is important to refer to the study, which indicates that it is the school culture, and not its type, that shapes background aggression. Thus, the statement about the equal prevalence of bullying should not be considered as a quantitative generalization, but as the participants' interpretation of the sources of risk, which emphasizes the role of internal factors: the level of staff training, relationships in the team and support from the administration.

Some researchers emphasize the need to use the position of a social moderator in special educational institutions to support the socialization of children with special needs (Mayhew et al., 2018). This idea is quite original, although it does not have sufficient empirical evidence. More reasonable are the views of those scholars who point to the need to counteract the motivation to bully as part of the fight against this phenomenon in general (Arifni & Firman, 2023). While the creation of separate administrative and pedagogical positions is more of a response to the consequences of the spread of bullying in student groups (Falla et al., 2021; Zhuravlova et al., 2021).

The proposed results also identify that strengthening communication and information exchange among teachers, parents, and school administrators is an important component of countering bullying. At the same time, the importance of training teachers and school psychologists to identify bullying in the early stages of its occurrence is also emphasized. At the same time, the problem of being overloaded with other tasks is a major obstacle, including in combating bullying in school groups. Respondents also noted the need to improve the level of training of teaching staff. The results correlate with the findings of other scholars that communication and discussion of the problem is an important step for its potential neutralization (Rochma, 2024; Charania et al., 2022). Therefore, an appropriate level of communication will allow for a prompt response to bullying, in particular at the early stages of its detection. Researchers also note that the heavy workload of teachers and school psychologists does not allow them to counteract bullying in a timely manner or to identify and remove the conditions for its occurrence (Boychuk et al., 2023; Milevska et al., 2022). This problem is universal and occurs in many educational institutions (Forber-Pratt et al., 2022; Abregú-Crespo et al., 2024). Some scholars suggest using digital teaching methods for children with special educational needs, which will significantly reduce contact with bullies (Drăghici, 2024). Such views are also still under-researched. In addition, bullying in the digital environment is an urgent problem for all age groups of students, which makes digital teaching methods a separate field for research experimentation.



Other scientists have drawn attention to the fact that ensuring effective counteraction to bullying requires innovative approaches, which include not only improving the qualification level of teaching staff but also creating conditions for reducing their professional workload (Oliinyk et al., 2023). One promising area may be the introduction of multidisciplinary support teams, which include specialists of various profiles and mediators (Pranintasari & Wachidah, 2021; Babych et al., 2022). In addition, it is advisable to develop a system of regular monitoring of the psychological climate in classrooms and the school environment as a whole, which will contribute to the timely identification of problems and intervention (Petrenko, 2021). Expanding social and emotional learning programs for students can also contribute to the formation of empathy, peaceful conflict resolution skills and responsible behavior (Schütz et al., 2022). Taken together, these measures can significantly increase the effectiveness of bullying prevention and provide a safe and supportive environment for all participants in the educational process. Moreover, in contrast to the generalized presentation, this section differentiated the responses according to the professional profile of the respondents. For example, it was shown that psychologists more often paid attention to the need to work with students' value orientations and empathy training. At the same time, teachers emphasized the lack of time and support. Parents demonstrated greater sensitivity to the issue of social isolation of children with special needs, and the administration more often mentioned the main difficulties in coordinating between services and implementing formalized procedures. This analysis avoids generalizations and emphasizes different perspectives on the problem depending on the role in the school community.

Therefore, although the study does not claim to create a new theory of bullying, it allows us to significantly expand the awareness of the problem in the context of inclusion. In particular, it demonstrates that bullying of children with special needs is the result not only of stereotypes or ignorance, but also of institutional helplessness - when the school lacks the resources or training to systematically counteract.

The methodology used in the study has certain limitations that should be considered when interpreting the information obtained. First, it is important to emphasize the sample of 40 people, which allows us to outline general directions. Obviously, involving a larger number of respondents in the experiment would make it possible to clarify many aspects of determining the motivation of bullies' actions against children with special educational needs.

Conclusions

This study aimed to identify socio-psychological factors that stimulate bullying of children with special educational needs and formulate practical pedagogical strategies that can effectively prevent such behavior.

First, the results of the study confirm that the main social triggers of aggression were internalized behavioral patterns obtained from informal adolescent groups and the digital environment (in particular, social networks), where aggression and humiliation are often romanticized or normalized. This observation coincides with the results of previous studies in the field of digital socialization.

Second, the psychological complexity of bullying lies in the aggressors' desire for self-affirmation against the background of their own inability to social integration. The feeling of impunity, reinforced by passive or inadequate reactions of adults (parents, teachers), creates a favorable environment for repeated aggression.

At the same time, children with SEN often become victims due to limited self-defense abilities, atypical behavior, and difficulties in social adaptation. These features can increase the risk of stigmatization and complicate the timely detection of bullying.

An important contribution of this study is the establishment that the form of the educational institution (inclusive or specialized) is not a determining factor in risk. Instead, the cultural climate of the institution, the level of empathy in the school community, and the preparedness of the staff play a decisive role. This



vision is consistent with modern theories of the school environment as a social microcosm, where stable patterns of behavior are formed.

The study also identified a number of effective pedagogical interventions, including: 1. formation of a stable channel of communication between teachers, administration, and parents; 2. implementation of targeted training for students on developing empathy; 3. professional training of teachers and psychologists on early diagnosis of bullying; 4. group practices that facilitate the adaptation of children with SEN to the school environment.

The main limitation is the small sample size and the predominance of a qualitative approach, which does not allow for statistically valid generalizations. In addition, not all categories of respondents were represented evenly, and the use of self-reporting could have affected the sincerity of the answers.

However, this study made a significant contribution to the understanding of bullying as a systemic phenomenon, rooted not only in the behavioral attitudes of children, but also in the structural and organizational conditions of the educational environment. It also emphasizes that effective counteraction to bullying requires institutional responsibility, multidisciplinary interaction, and a change in the pedagogical paradigm towards inclusion.

In further research, it would be advisable to combine qualitative and quantitative methods to test the hypotheses put forward, as well as focus on a thorough comparative analysis of different school environments.

Declarations

Funding

No financing.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions and participant confidentiality.



Acknowledgements

Not applicable.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

AI Transparency Disclosure

Since the authors are not native speakers of English, which is their second language, this text has been linguistically optimized using an artificial intelligence-based tool (ChatGPT, OpenAI) and then carefully edited by experts in academic writing to ensure compliance with the standards of scientific English.

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ONLINE ISSN: 2665-0223
PRINT ISSN: 1856-7576