Eduweb

Revista de Tecnología de Información y Comunicación en Educación

Online ISSN: 2665-0223
Print ISSN: 1856-7576

Volumen 18, No. 4.
Octubre - Diciembre 2024

Universidad de Carabobo
Facultad de Ciencias de la Educación

Depósito legal: pp200702CA2520
ISSN: 1856-7576

Código Revencyt: RVE022
Registrada en el Catálogo Latindex con el número de folio 19424

Comisión de Arbitraje

Dirección de la Revista: Apartado de Correo 3812, Oficina de correos Trigal Sur, Valencia, Edo. Carabobo. Venezuela.
Correo electrónico: revistaeduweb@gmail.com

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.

Los contenidos de los trabajos publicados en la revista son de entera responsabilidad de los autores.

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.

DE LOS FINES Y PROPÓSITOS DE EDUWEB, REVISTA DE TECNOLOGÍA DE INFORMACIÓN Y COMUNICACIÓN EN EDUCACIÓN

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.

Contenido

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.0
Cómo citar:
Medina, E. (2024). Editorial. Revista Eduweb, 18(4), 7-8. https://doi.org/10.46502/issn.1856-7576/2024.18.04.0

EDITORIAL

La Revista Eduweb celebra a través de su Volumen 18 Nº 4 el cierre de este año, reconocemos el aporte de investigadores de distintas partes del mundo con el mismo objetivo de publicar los resultados trascendentales de sus respectivas investigaciones. Ha sido un año marcado por las múltiples miradas que han surgido tras la avasallante necesidad de integrar la Inteligencia artificial a nuestro acontecer diario como a la educación, una pequeña muestra de ello la podemos apreciar en los innumerables foros, seminarios y congresos con el mismo propósito de analizar y reflexionar sobre el impacto de IA en la educación, planteamiento frecuente es la discusión sobre los retos y desafíos que enfrenta la educación de cara a lo que está pasando justo en estos momentos entre el lenguaje humano y lenguaje de la máquina. El uso del lenguaje como sistema de signos y máxima expresión del ser humano sigue ocupando el lugar preponderante en la forma cómo se está escribiendo la historia contemporánea y, más aún es por medio del lenguaje que estamos interactuando con una máquina capaz de respondernos, entonces partimos del principio sobre el cual se cierne que el lenguaje es una fuerza generadora y creativa tal como se expresa desde la filosofía gadameriana. En ese sentido, es conveniente atender la importancia, el significado y los elementos básicos que subyacen en la competencia lingüística para expresar una idea.

Este planteamiento surge de la mirada curiosa tras conocer la importancia de un Prompt como vehículo por medio del cual formulamos preguntas que, esperamos nos brinde la información más exacta posible, con elevado componente de validez y credibilidad; esto nos lleva a la reflexión sobre la idea de la producción escrita más allá de la unión de ciertas palabras acompañadas de adjetivos que reflejan una coherencia y cohesión emblemáticamente recocidas como texto. Es claro que, desde la lingüística la pregunta del Prompt debe estar escrita siguiendo un objetivo, un contexto y una delimitación para que la máquina pueda hacer su trabajo y darnos aquello que estamos buscando, de modo que nos enfrentamos a la necesidad de seguir formando generaciones entusiasmadas por la rapidez de la información. La base sólida es que el lenguaje es comprensión y es por lo que la lectura y escritura crecen exponencialmente como competencias en la experiencia de vida en una sociedad que gira en torno a la información.

Es indiscutible que la IA puede analizar y resumir gran cantidad de información, la interacción con entornos digitalizados y recientemente la creación de contenidos como la automatización de informes, proyectos e inclusive la creación de artículos científicos, nos lleva a pensar en que la lectura y escritura seguirán siendo competencias imprescindibles en medio del auge de la Inteligencia artificial. El lector consolida sus conocimientos como experiencia previa y la escritura registra el potencial creativo del ser humano para recrearse en el lenguaje hasta expresar sus ideas.

Mientras mejor lectores y escritores formemos, la tarea de usar la máquina ya se transforma en una herramienta de apoyo y podríamos profundizar en la integración de la tecnología a las tareas cotidianas de nuestros estudiantes.

Con gran entusiasmo exponemos los títulos que conforman el cierre del Volumen 18. Inicia este número con el trabajo “RSE Laboratorio de modelado de sistemas físicos con ciencia aplicada” en el que su autora plantea el diseño de un laboratorio de servicio itinerante para el desarrollo del concepto de promoción de la investigación científica. “Metadimensionalidad de las tecnologías de información y comunicación en la educación médica” este documento atiende el aprendizaje significativo en el proceso de formación en Ciencias de la salud. La investigación titulada “Educación inclusiva en Ucrania: logros, retos y perspectivas” concluye que las consideraciones éticas son de gran relevancia en las prácticas de educación inclusiva. Por su parte el artículo: “Tecnologías innovadoras en el desarrollo de la competencia profesional de los profesores” sus autores

destacan los principales tipos de tecnologías innovadoras. Así también el trabajo “Estrategias de interacción interpersonal para el desarrollo de habilidades comunicativas en la formación universitaria” concluye con un método desarrollado por su propio autor vinculado con la interacción interpersonal en la formación de la competencia comunicativa. Encontrarán otro trabajo que tiene por objetivo investigar el potencial de la realidad virtual que se titula: “El potencial de la realidad virtual en el modelado de procesos científicos complejos para la educación a distancia: una revisión del alcance”.

Más adelante podrán leer: “La integración de aplicaciones web en programas de aprendizaje integrado de contenido y lengua (CLIL) en la educación superior: contexto ucraniano”, Este estudio determina el impacto de las aplicaciones basadas en la web en el desarrollo de las competencias lingüísticas. En un octavo orden de títulos presentamos: “Formación de pensamiento crítico en los alumnos de primaria mediante tareas basadas en problemas” centrado en el desarrollo del pensamiento crítico como componente esencial de la educación moderna. La investigación: “Desarrollo profesional de docentes de educación física a través de tecnologías innovadoras” obtuvo datos que indicaron un cambio en el proceso educativo de los futuros profesores de cultura física. Otra investigación para explorar la representa el artículo: “Uso del portafolio virtual para la gestión del aprendizaje de estudiantes de postgrado” cuya implementación del portafolio digital en Google Drive fue utilizado como herramienta en la gestión del aprendizaje. Adicionalmente el estudio: “La influencia de las actividades socioculturales en el desarrollo de las competencias sociales” estuvo centrado en la eficacia del programa de influencia sociocultural en la dinámica de las habilidades comunicativas. Exponemos también el artículo: “Adaptación del enfoque comunicativo a la enseñanza del inglés en la educación superior” el cual examina la eficacia de la adaptación del enfoque comunicativo a la enseñanza del inglés. Posteriormente, el trabajo: “Cooperación científica internacional y mecanismos organizativos y programáticos nacionales”, su autora examina el panorama cambiante de la cooperación jurídica internacional en materia de investigación científica en el derecho ucraniano. El trabajo titulado: “Métodos para desarrollar la resistencia psicológica en estudiantes de ingeniería bajo condiciones estresantes”, cuyo objetivo consistió en explorar métodos para mejorar la resistencia psicológica de los estudiantes de ingeniería.

Un recorrido cognitivo por: “El impacto del aprendizaje basado en aplicaciones móviles y IA en la comprensión de variables aleatorias discretas” les permitirá conocer la conclusión sobre la combinación de Tecnologías del aprendizaje y conocimiento con Inteligencia Artificial para la resolución de problemas reales. Pueden también explorar el artículo: “Mejora de la capacidad de pensamiento crítico de los alumnos mediante la educación orientada a proyectos” que está dedicado al estudio y evaluación del pensamiento crítico. Otro estudio “El impacto del coaching en el desarrollo profesional de los especialistas en TI: un análisis empírico” tiene como objetivo evaluar el impacto del coaching en la autorrealización profesional. Una interesante contribución titulada: “Impacto de las tecnologías digitales en la calidad de la educación superior”, en la que sus autores presentan el concepto de "tecnologías digitales" y proponen una clasificación. Un tema de examinación lo representa el artículo: “Financiación del sector de la educación y la investigación en tiempos de Guerra” el mismo pone de relieve las últimas tendencias en el cambio de las direcciones y enfoques de la financiación de la esfera educativa y científica de Ucrania en el contexto de la guerra. Finalmente, cerramos este número con un interesante tema expuesto en el trabajo de investigación: “Medios digitales y su impacto en la salud mental y la identidad”. Sus investigadores estudiaron la relación entre los estudiantes de educación media en Colombia y la era digital.

Este número está dedicado a toda la comunidad lectora de investigadores, estudiantes y docentes apasionados por el tema de la tecnología y la educación. El disfrute de la lectura es un modo de vida.

Elsy Medina
Universidad de Carabobo, Venezuela.

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.1
Cómo citar:
Sandoval-Ruiz, C. (2024). RSE Laboratorio de modelado de sistemas físicos con ciencia aplicada. *Revista Eduweb*, *18*(4), 9-25.
https://doi.org/10.46502/issn.1856-7576/2024.18.04.1

RSE Laboratorio de modelado de sistemas físicos con ciencia aplicada

CSR laboratory code of social-environment responsibility for the optimization of physical systems with applied science

C. Sandoval-Ruiz
https://orcid.org/0000-0001-5980-292X
cesandova@gmail.com
Facultad de Ingeniería, Universidad de Carabobo, Investigadora, Venezuela.

Recibido: 03/06/24
Aceptado: 24/10/24

Resumen

Se plantea el diseño de un laboratorio de servicio itinerante para el desarrollo del concepto de promoción de la investigación científica sobre criterios de responsabilidad social y ecológica - RSE. La metodología consiste en un conjunto de ensayos de ciencia con propósito para generar la propuesta de una plataforma de investigación, basado en estaciones para el estudio de principios físicos, herramientas de monitoreo y entrenamiento de modelos en línea, a fin de facilitar el estudio de casos de forma remota. Entre los hallazgos se encuentra la correlación de ciencias aplicadas para rehabilitación de mascotas, optimización de sistemas de energías renovables, turismo científico, rehabilitación de condiciones ambientales en modelos de glaciación, reciclaje inteligente de componentes electrónicos en nuevas tecnologías, valorización cultural en la enseñanza de la física, modelado matemático remoto y educación en valores con ciencia. Lo que permite concluir que la propuesta puede ser presentada a empresas como modelo de tecnología circular y líneas de I+D+i, en el marco de programas de RSE.

Palabras clave: Gemelos digitales, Laboratorio itinerante, Principios físicos, Programa I+D, Responsabilidad Social-Ambiental.

Abstract

The design of a traveling service laboratory is proposed for the development of the concept of promoting scientific research on criteria of social and ecological responsibility - CSR. The methodology consists of developing science trials with a purpose to generate the proposal of a research platform, a set of stations for the study of physical principles, monitoring tools and training of online models, in order to facilitate the study of the units remote form. Among the findings is the correlation of applied sciences for pet rehabilitation, optimization of renewable energy systems, scientific tourism, rehabilitation of environmental conditions in glaciation models, intelligent recycling of electronic components in new technologies, cultural valorization in the teaching of physics, remote mathematical modeling and values education with science. Which allows us to conclude that the proposal can be presented to companies as a model of circular technology and R&D&I lines, within the framework of CSR programs.

Keywords: Digital twins, Traveling laboratory, Physical principles, R&D Program, Social-Environmental Responsibility.

Introducción

Actualmente, los laboratorios de ciencias físicas, matemáticas y naturales pueden ser integrados para la construcción de teorías, conjeturas y postulados, a travé del modelado de sistemas complejos. El objetivo de la educación en ciencias es lograr incentivar la investigación científica y aprendizaje de nuevos conocimientos. En tal sentido, las carreras tecnológicas, aplicaciones sociales y estudios de factibilidad ambiental de proyectos son compatibles en un marco de integración de ciencias aplicadas. Es por ello, que se plantea una propuesta pedagógica fundamentada sobre tecnología TIC para ampliar el alcance de estos campos, sumados en iniciativas de I+D y programas de responsabilidad social y ambiental – RSE, promoviendo el interés por la ciencia desde etapas tempranas de la formación académica. Los proyectos están planteados como innovaciones de bajo costo, que pueden ser replicados para ofrecer soluciones de amplio impacto para el bienestar integral, implementados sobre laboratorios itinerantes.

1) Visión empírica: Experimentación sobre elementos cotidianos disponibles en el entorno. El objetivo es relacionar experimentos físicos complejos con prácticas cotidianas, en un contexto que simplifica el estudio de modelos científicos. (a) Los espejos y helióstatos de concentración solar, resonancia óptica y reorientación de luz. (b) los papagayos con sus colas de sustentación para el estudio de aerodinámica en cometas eólicas. (c) los trompos, la rotación y efecto giroscopio con las turbinas. El estudio en placas cimáticas de los patrones de frecuencias y su relación con la geometría, en el campo de la física de ondas y matemática aplicada.
2) Gemelos digitales: Modelos matemáticos del sistema físico (no intervenible) de estudio, con TICs. Existe el compromiso por estudios sobre modelos biomiméticos, para garantizar la integridad de la fauna y los seres vivos. Esto de la mano con la capacidad de cómputo actual en hardware paralelo, para alcanzar modelado de alto desempeño, con el propósito de no recurrir a la experimentación con animales, reivindicando ese tipo de prácticas innecesarias y cuestionables y fomentando programas de conservación y mejoras en la calidad de vida de la fauna.
3) Laboratorio itinerante: Acceso al equipamento especializado del laboratorio. Está justificado en experimentos sobre condiciones relativas en regiones específicas (glaciación, Coriolis, campos gravitatorios en dinámica de fluidos para conversión de energías renovables o campos magnéticos, en la medición de radiación solar o ferrofluidos en la corteza terrestre).

Proyecto compensación: La creación de un campo magnético inducido para proteger a la biosfera y ecosistemas (glaciares) de las radiaciones solares selectivamente en zonas específicas, regulando las proporciones de ferrofluidos magnéticos en vórtices controlados (cometas de plasma confinada), para definir un campo regenerativo mediante la trayectoria del fluido magnético.

Ciencia con propósito. Los sistemas físicos pueden ser interpretados de acuerdo con el observador, la selección de variables físicas y el nivel de abstracción. La simplificación más eficiente corresponde a la generalización del modelo para su ajuste mediante parámetros, enfoques configurables (lente de formulación dinámica) y esto se logra con un método de construcción del pensamiento mediante el debate, análisis y síntesis, siendo las directrices de la pedagogía científica.

La observación, comprensión de principios físicos y fundamentos matemáticos, desarrollando un método, a partir de planteamientos que permitan reutilizar conocimientos. Desde la estimación del número de hojas de un árbol, mediante una progresión geométrica $a_n = a_1 \cdot r^{n-1}$, considerando la distribución de las hojas en las ramas como una composición fractal. Donde se deberá proponer una ecuación modeladora por fracción del problema y simplificar el cálculo mediante la concatenación de etapas (ramas). El principio será identificar una patrón básico, ajustar el modelo y extrapolar, finalmente realizar un ajuste generalizado.

$$a_n = a_1 + (n-1) \cdot r + a_1 \cdot r^{n-1} + b_n$$

Con el diseño de experimentos didácticos se busca incentivar el desarrollo de aplicaciones RSE en carreras STEM (ciencia, tecnología, ingeniería y matemática), a través de la construcción de modelos matemáticos y aplicación de gemelos digitales (con alta capacidad de cómputo sobre hardware paralelo), con el objetivo de acercar la ciencia a servicios ambientales, en los distintos campos de investigación. Esto se puede lograr diseñando el concepto de un laboratorio de responsabilidad socio ambiental, con estaciones básicas para la interpretación de principios físicos, que se concatenen para ofrecer soluciones a problemas complejos, a través de proyectos multietapas.

Este enfoque aporta una alternativa para hacer accesible la experimentación científica a las comunidades remotas, a través de laboratorios itinerantes que cuenten con estaciones teleoperadas, con aplicaciones funcionales como un módulo de rehabilitación para mascotas, que pueda ofrecer un servicio a los animales con desgaste articular, condiciones neurológicas y limitaciones visuales. De esta manera, se está educando en valores, con ciencia aplicada (modelado matemático y estudio de principios físicos en los mecanismos ortopédicos). En el mismo orden de ideas, definir la recuperación de energías renovables que se puedan recircular del entrenamiento, diseñar los mecanismos con componentes reciclados y aplicar tecnología de gemelos digitales para la experimentación biomimética, a fin de garantizar procedimiento no invasivos, cumpliendo con el criterio ético de bienestar integral. Hasta este punto, la propuesta pedagógica es diseñada por parte de los innovadores, pero la naturaleza itinerante del laboratorio permite sustentar una iniciativa dinámica, que se va adaptando a las condiciones locales, potencialidades y componentes culturales, es decir, aplicar técnicas como juegos tradicionales para la enseñanza de la física, levantamiento de mapas de potencial en recursos energéticos y propuestas desarrolladas por los participantes en una competencia colaborativa, dotando a la actividad de una postura activa por parte de los usuarios.

El diseño de los proyectos será particular al escenario de la región visitada, tendrá entre sus aspectos relevantes, la integración de tecnología interactiva, videos didácticos con experimentos remotos y guías de análisis sobre gemelos digitales, aplicando un conjunto de TICs que faciliten el cumplimiento de los objetivos prácticos. De esta forma, en las regiones se podrá establecer reciclaje eco-responsable aplicado a la ciencia, iniciativas de conservación de las calidad de vida de la fauna y optimización de los recursos energéticos, mediante cometas de monitoreo, redireccionamiento y optimización de los recursos como lentes de regeneración del potencial de energías renovables.

1) Levantamiento de mapa de recursos para diseño de arquitectura bioclimática sostenible.
2) Estudio de geometría proyectiva para colocación de cometas reflectantes (espejos) para redireccionamiento de vistas de escenarios naturales en complejos arquitectónicos.
3) Análisis de similitud de modelos matemáticos de síntesis de tejidos y compuestos químicos.
4) Observación de mecanismos de optimización de fauna para diseño biomimético.
5) Centro de rehabilitación de salud de mascotas, mecanismos ortopédicos y diseño de órtesis, considerando iniciativas de RSE especializadas para impresión 3D de órtesis funcionales (Cruz et al., 2024), rehabilitación (Guzmán & Aguirre, 2024), incorporando acoples de amortiguación en tratamiento de movilidad y visión asistida.
6) Gemelos digitales para la experimentación en tecnologías regenerativas e ingeniería de tejidos.
7) Reciclaje de componentes electrónicos y energía en los laboratorios itinerantes.
8) Modelo matemático de sistemas físicos y compuestos químicos mediante participación activa, con enfásis en turismo científico del laboratorio móvil[1], compensación de impacto ambiental. Rehabilitación y regeneración: sistemas mediante gemelos digitales, en condiciones controladas.

[1] Estimular el interés hacia la ciencia sería definiendo “rutas escénicas” (Tabla 1) basadas en centros de interpretación, en el marco de lo que se conoce como turismo científico. “El estudio de fenómenos ópticos como las auroras boreales, australes, reflectancia de luz solar (salar de Uyuní, Bolivia), fenómenos eléctricos (relámpago del Catatumbo, Venezuela), efecto Coriolis (Ecuador), potencial de irradiación solar en el desierto (Atacama, Chile), ciclos de glaciación (Calafate, Argentina), entre otros tantos”.

Tabla 1.
Estudio de Fenómenos con Potencial de reutilización de energía fotónica

Descripción del Fenómeno óptico - eléctrico	Zonas de Fenómenos
Relámpago del Catatumbo, Venezuela. El estudio de las características físicas del fenómeno meteorológico de descargas eléctricas formadas en la atmósfera, como un condensador natural, para la definición de técnicas de recuperación de energía a partir de luz emitida en las capas de la atmósfera, aprovechamiento indirecto de la energía producida en el fenómeno y diferencial de temperatura.	
Salar de Uyuni, Bolivia. Estudio del fenómeno óptico de efecto espejo, que permite caracterizar el *Albedo* que se presenta sobre superficies blancas, donde la luz solar incidente puede ser reflejada en un alto porcentaje, de manera que puede ser reutilizada en los paneles solares (arreglos bifaciales), para la captación de luz solar reflejada. Por lo que tiene un comportamiento sobre modelo de realimentación.	
Laguna de Manialtepec, México Se trata de la producción de luz de ciertos organismos mediante una transformación de energía química a luminosa y es observado en insectos y hongos, pero también en cuerpos de agua, generalmente en ecosistemas marinos.	
Halo Solar, pilares de luz y Difracción de luz Solar en Atacama, Chile Se debe a un fenómeno de refracción de la luz en los cristales de hielo que forman las nubes más altas. Estos fenómenos ópticos pueden ser estudiados para el aprovechamiento de la luz difusa en fotovoltaica.	
Auroras Australes en Ushuaia, Argentina Es un fenómeno en forma de luminiscencia que se presenta por ionización atmosférica, generalmente en zonas polares, aunque puede aparecer en otras zonas del mundo durante breves períodos. En el hemisferio sur es conocida como aurora austral y en el hemisferio norte como aurora boreal.	

Tal como enseñar valores es la base de la educación, un modelador universal requiere contar con métodos de aproximación basados en criterios de sostenibilidad, estabilidad y eficiencia, priorizando entre estos principios.

Referentes teóricos

La propuesta comprende un laboratorio guiado de ensayos de física para el estudio de principios de conservación de energía (Sandoval-Ruiz, 2024), mediante mecanismo simples que estén accesibles para

el estudiante, a fin de realizar la primera etapa de investigación en la deducción de modelos físicos, que serán aplicados de manera concatenada para la descripción de sistemas complejos, entre los tópicos seleccionados se presentan los principios de la Figura 1.

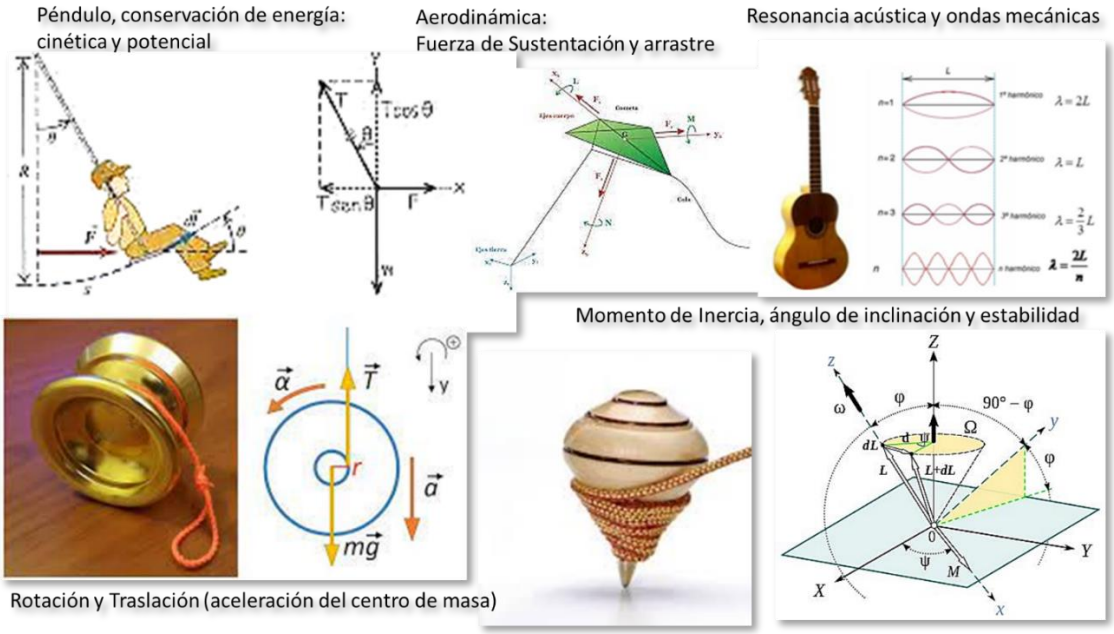

Figura 1. Juegos Tradicionales como identificador de patrones de estudio de principios físicos

El estudio de sistemas concatenados de ejes como el giroscopio que realiza una compensación mediante simetría de rotación, produciendo un momento angular girando respecto a un tercer eje, por suspensión cardán (permite mantener la orientación de un eje de rotación en el espacio, independientemente del movimiento del soporte). Así como sistemas fractales, momento angular cuántico (espín), la espintrónica, física de partículas en configuración de metamateriales. Un trompo girando sobre la órbita de otro trompo (vector momento angular orbital), se puede definir como un momento angular fractal, mediante la combinación de su momento angular orbital y su momento angular intrínseco o propio (Figura 2).

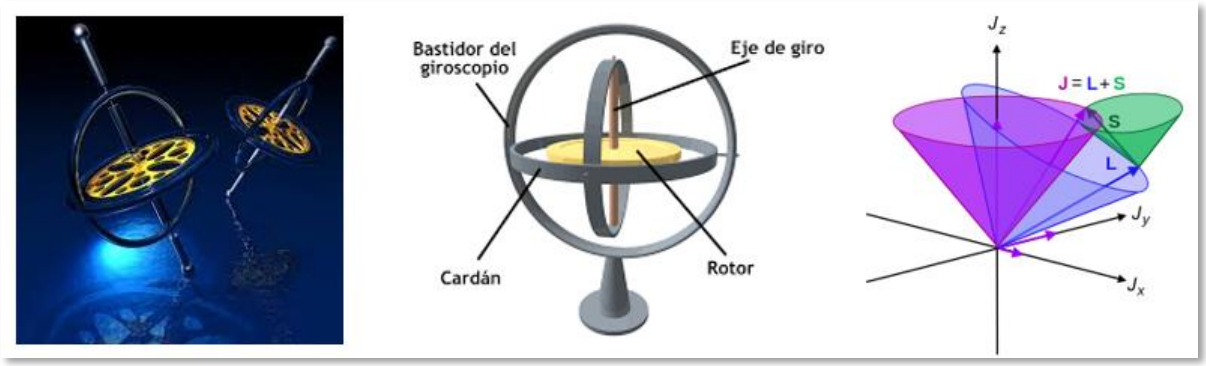

Figura 2. Concatenación de principios físicos en Sistemas Compuestos.

Se puede afirmar que la ecuación modeladora, es una expresión algebraica, que considera la descripción de patrones *xyz* superpuestos en el tiempo: Expresar un sistema físico, a partir de una secuencia de aportes de energía, como un polinomio (una suma finita de productos de variables (con exponentes enteros positivos) y coeficientes (constantes, que en el modelo extendido pueden ser variables en alguna

dimensión de la composición fractal). El circuito LFSR se considera un generador de polinomios, donde la caracterización del sistema depende de los coeficientes y la configuración de la arquitectura del arreglo.

1. Coherencia cuántica de las ondas.
2. Ondas fractales.
3. Neuro-modelo equivalente de espacio de estados.

Un sistema físico multidimensional tendrá variables en el espacio, dinámico (variante en el tiempo), un ángulo de alineación respecto a la energía y una dimensión de información por entrelazamiento cuántico, los patrones que describen la trayectoria orbital, lo que permite el estudio de comportamiento (como antenas captadoras de energía) y la proyección de una superficie plana en forma de girasol sobre una geometría 3D. Por lo que se plantea la construcción de modelos fractales, basado en reconocimiento de patrón o la estructura del todo de forma continua, mediante iteraciones matemáticas.

Casos de Estudio. Análisis de Modelos Dinámicos, Osciladores acoplados y correspondencia

Se asume una consideración de partida: un muelle (matriz elastomérica) es un filtro de osciladores resonantes que interactúan entre sí, entonces se convierte en el elemento de amortiguación mecánico, recibe la información de fuerza aplicada, se filtran componentes útiles y se redirecciona de manera amortiguada, con efectos positivos regenerativos. ¿Pero en ese caso, se puede decir que está absorbiendo energía? La respuesta es sí, en caso de que no se esté disipando de alguna manera, el objetivo es reciclarla, esto recirculando la energía de los componentes filtrados.

Probabilidades, ordenamiento cuántico y entropía

Entendiendo la entropía bajo el principio de que “todo evoluciona a su configuración más probable”. Establecer un modelo probabilístico simétrico, ¿qué representa?, ¿se podrían definir estados reversibles?, es decir, que se pueda volver al estado original luego de un intercambio de energía. Entonces, las probabilidades según la entropía pueden compensarse para restablecer una condición, por la dinámica temporal, considerada más probable.

1. Definir una perspectiva para el análisis del sistema.
2. Identificar las variables idóneas, según los objetivos de modelado, sin sesgo teórico.
3. Establecer un análisis fractal de compensación simétrica, para el modelado del sesgo empírico.
4. Ajustar los cambios de variable de simplificación pertinentes.
5. Rediseñar el modelo en función de términos de niveles de abstracción fractal.

Un modelador LFSR permite establecer el modelo matemático como un código, es decir un generador de patrones, con las directrices de la secuencia, donde el arreglo móvil presenta órbitas sincronizadas para establecer una dinámica compatible. Los efectos residuales de energía, ruidos, perturbaciones como turbulencia o desprendimiento de vórtices, son detectados por el modelo en la etapa de decodificación. La correlación del LFSR, se genera una matriz de síndrome, donde se definen los elementos simétricos de compensación que sumados al patrón de salida logra anular el efecto ruido y filtrar los componentes residuales, para alcanzar el equilibrio dinámico del sistema, mediante la adición de armónicos con las características de pesos sinápticos y alineación de ángulo, en resonancia óptima fractal del sistema físico. La energía inteligente es un concepto que se ha desarrollado sobre la base de un modelo matemático donde se calculan los coeficientes, a fin de establecer los aportes útiles de energía y reciclar los componentes de energía residual, a fin de mitigar los efectos sobre el ambiente, para proteger los ecosistemas del sistema de captación de energías renovables.

La investigación científica con consciencia es un equilibrio dinámico, entre la organización estructurada del conocimiento y la responsabilidad ambiental, con un espacio de innovación. Actualmente, existen algoritmos que realizan el modelado de sistemas, el rol del científico y observador es establecer los

principios, valores y criterios de diseño, que serán determinantes en la selección de las variables, así como los términos de sesgo, que le dan identidad al modelo. En resumen, desaprender modelos y volver a interpretar con criterios sostenibles (Sandoval-Ruiz, 2020).

Proyectos de modelado de convertidores de energía inteligente (Tabla 2), la energía residual se reconvierte en energía útil, sin causar daño al entorno, es responsable y autoorganizada en un mecanismo de compensación fractal de efectos. Creando un circuito aislado, para la anulación de campos y su efecto sobre las condiciones circundantes. Analizar el filtrado de componentes y la energía transformada. Definir a los grupos en diferentes perspectivas para describir un modelo[2], modificar la alineación y promover la formulación de conclusiones.

Tabla 2.
Propuesta tecnológica de energías renovables basados en potencial local

Proyecto	Descripción del Proyecto
Optimización de Parques de aerogeneradores, a través de lentes eólicos implementados por tecnología *Soft-Kite*	En respuesta a la necesidad de optimización del rendimiento y la implementación de criterios de responsabilidad ambiental en los parques eólicos, para mitigar el efecto de las turbinas eólicas sobre el patrón de flujo, se propone formular un modelo neuronal con los datos fluidodinámicos de la planta, representado por coeficientes de optimización sobre ecuaciones matemáticas parametrizables, para el soporte de adaptación del hardware, para un arreglo adaptativo de captadores de energía eólica, que permita establecer una relación entre la energía incidente (considerando la energía reflejada por otros elementos del arreglo), energía captada, recirculación de energía residual y compensación, en un mecanismo regenerativo (lentes eólicos implementados a través de cometas) a la salida del arreglo, optimizando la eficiencia, a partir de los componentes instalados.
Plantas fotovoltaicas a con técnicas de geometría proyectiva	Desarrollo de un laboratorio móvil de diagnóstico y mantenimiento predictivo para plantas fotovoltaicas (Sandoval-Ruiz, 2024), aplicando elementos de inspección por geometría proyectiva, **a fin de configurar la altura del proyector y establecer un arreglo dinámico de concentradores solares para redireccionamiento centralizado de luz solar, minimizando el número de componentes del sistema de seguimiento MPPT, con el objetivo de cubrir una superficie extendida del parque fotovoltaico, de forma eficiente**. Esto mediante la combinación del modelo matemático, la formulación de filtros adaptativos (por longitud de onda λ), sincronización de trayectoria para máxima eficiencia, optimización del ángulo de proyección, configuración dinámica del índice de refracción *m*, permitiendo movilizar el banco de pruebas: arreglo de cometas captadoras y lentes reconfigurables por la región y optimizar los parámetros, minimizando el número de componentes, a través de un único mecanismo centralizado de cascada de fotones, considerando modelos físicos de receptores de caídas de partículas (FPR).
Undimotriz y sistemas de almacenamiento de energías Renovables ESS por Reutilización de infraestructura	La solución de ingeniería de modelo circular para reconversión de plantas de energía en sistemas estratégicos de almacenamiento de energías renovables, está enmarcada en el amplio potencial de líneas costeras, que dota de una capacidad asociada a los puertos de descarga de combustible en la infraestructura energética instalada, lo que permite plantear como meta una adaptación, mediante un modelo genérico del activo, para estimar la rentabilidad por unidad de reconversión, así como el ahorro en activos y el impacto ambiental. El primer factor determinante debe venir de la implementación de tecnologías verdes innovadoras, en el marco de alianzas estratégicas de transferencia tecnológica. Estas tecnologías se deben caracterizar por flexibilidad, reutilización de hardware y energía, cero residuos y mínima intervención de espacios.
ERNC-DAT un software de levantamiento de datos, co-diseño y gestión inteligente	Software de gestión sobre modelos matemáticos, comprende una etapa de levantamiento de datos para contar con un inventario de potencial, en las áreas de infraestructura, recursos, equipos, talento humano y energético de la región. Se plantea la aplicación de conceptos como gemelos digitales para la interacción entre la planta física y sistema digital de monitoreo, LiDAR para la actualización dinámica de planos y IED dispositivos electrónicos inteligentes para la configuración de las etapas por tecnología de hardware reconfigurable FPGA.

[2] La propuesta comprende un laboratorio itinerante para visitas en parques de energías renovables, estudio de potencial mediante escaneo con cometas solar-eólicos, modelado matemático en sitio que permita adaptar las soluciones técnicas y propuestas de optimización con tecnología avanzada del laboratorio de física aplicada.

Metodología

Se plantean casos de estudio, el experimento consta de dos etapas por equipo de investigación, en una primera se establece una unidad de análisis para definir, en la segunda etapa, se deben establecer líneas alternativas y sobre la base de ambas líneas, desarrollar debates aplicando TICs, para fortalecer la inferencia. Se deberá registrar de forma detallada las ideas, documentar las alternativas de solución y validación mediante análisis teórico y estudios de naturaleza empírica, sin alterar los ecosistemas del estudio, aplicando el conocimiento con responsabilidad ambiental. Se promueve ampliar la capacidad de reconocer patrones complejos por memorización de estelas de trayectoria. En este sentido, se propone retomar esta técnica, para el análisis de flujo aerodinámico, el grabado de las olas, ondas en movimiento y establecer la observación científica de los ciclos y líneas de tiempo de las variables físicas, su efecto sobre la arquitectura del espacio tiempo, movimiento y energía.

Se pretende contrastar los postulados con teorías de Física de partículas, aporte de energía cinética y energía de reposo (asociada a la masa de la partícula), velocidad relativa respecto al sistema de referencia. La masa de las partículas dada por la interacción con el campo (entrelazamiento), en una superficie imaginaria de campo acotado se tiene un criterio de simetría y equilibrio (biestable) para definir el comportamiento del sistema y las consideraciones para desmontar el modelo clásico y reinterpretación por dualidad. Todo cuerpo en estado de reposo mantiene un potencial de energía acumulada, al ser perturbado, rompe su inercia y crea una interacción con el medio, donde la medición del efecto viene a ser la variable medible, por lo que los modelos están acotados por las dimensiones físicas conocidas.

En el método de modelado se asignan fragmentos de teorías, modelos o postulados iniciales, se crea un espacio de debate con una red de arquitectura radial, para estimular la ponderación de la teoría, se avanza sobre la trayectoria colocando los postulados más cerca o lejos según la compatibilidad. Así se asignan pesos sinápticos complejos *w*, con un componente que corresponde al radio y un componente correspondiente al ángulo, con el objetivo de alcanzar el punto óptimo. Así mismo la experimentación sobre modelos corresponde a la aplicación de π gemelos digitales, donde se intenta lograr la convergencia entre la tecnología (cómputo paralelo en VHDL), la física y la matemática, especialmente basada en LFSR con geometría de progresión geométrica π. Estas herramientas generalmente aplicadas en sistemas de control de plantas, resultan especialmente útiles para desarrollos de modelos biomiméticos, ensayos de bioingeniería, modelos de ecosistemas y sistemas físicos no intervenibles. El gemelo digital corresponde a una representación matemática de sistemas físicos en un entorno virtual y simular su comportamiento, estado y rendimiento (Chicaiza et al., 2024).

Iniciativas de ciencia aplicada a RSE

Se han desarrollado un conjunto de proyectos desde el laboratorio de microcontroladores, los cuales han tenido un enfoque de asistencia social y ambiental, donde cada grupo de estudiantes implementan las etapas de la asignatura en una aplicación de innovación tecnológica. El primer factor a mencionar es la motivación de los integrantes, adquiriendo destrezas para formalizar el conocimiento práctico. (1) Implementación con materiales reciclado, (2) investigación teórica para el diseño de mecanismos óptimos, donde se logre el menor consumo de energía en los accionamientos, (3) formalización de la experiencia en la producción de un artículo con rigor científico para documentar los hallazgos.

Una fórmula metodológica es proponer proyectos de diseños innovadores para ser presentados en seminarios y congresos. El resultado corresponde a aplicaciones de robótica asistencial, sillas de ruedas (Valero et al., 2012) , dispensadores de alimentos para mascotas teleoperado a través de microcontroladores para iniciativas de responsabilidad socioambiental (Figura 3), que pueden ser implementados en programas RSE de empresas y grupos de investigación.

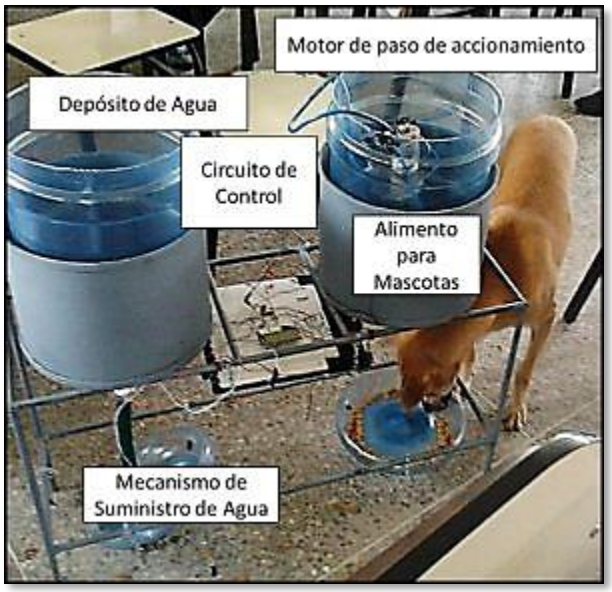

Figura 3. Iniciativas implementadas en Proyectos RSE.

Resultados y discusión

Se ha planteado la enseñanza de la ciencia a través de proyectos, ya que como estrategia permite al estudiante (en el campo de STEM, ciencia e ingeniería) involucrarse de forma activa (Tuyarot, 2015), se selecciona un tema científico de actualidad, se realiza el estudio de los principios enunciados y se plantea una generalización desde el enfoque físico-teórico. La investigación científica cumple con el método de alcanzar un aprendizaje significativo, que está respaldado por el interés del investigador en probar las inferencias, siendo las herramientas TIC un recurso fundamental (Echeverría et al., 2024). Por otra parte, habilidades como el análisis crítico, creatividad, resolución de hipótesis, colaboración fomentada por la estrategia de proyectos de investigación, representan un impacto socio ambiental positivo por la aplicación de metodología de educación STEM (Chiliquinga et al., 2024).

Caso I. Técnicas de aislamiento de materiales en soluciones diluidas (Yan et al., 2024). La extrapolación de técnicas de aislamiento a un componente genérico configurado con carga y reactividad específica, en el marco de materiales fluidos programables, que permita aislar un elemento en la matriz de fuente diluida, aplicando análisis espectral, para establecer la frecuencia de resonancia, como método físico de aislamiento selectivo, con el fin de establecer una técnica ecológica y eficiente energéticamente. Todo esto en aplicaciones de reciclaje selectivo, configuración dinámica y comportamiento inteligente de materiales a nivel industrial, lo que aporta en el modelo circular de las tecnologías.

CASO II. Para el tratamiento espectral de componentes se requiere la implementación de la transformada cuántica de Fourier TCF (Marín, 2022). El procesamiento a través de operadores de convolución $\otimes$, aplicando teoría de grupos en algebra de Galois, donde se establece el reconocimiento de la estructura LFSR para circuitos cuánticos en el algoritmo de TCF con operadores de la forma: $a^k mod Q$, siendo soporte en producto tensorial y compuertas cuánticas, implementadas sobre tecnología FPGA (Torres, 2023).

CASO III. Estos conceptos pueden ser aplicados para tecnología fotovoltaica tándem (Xahuentitla & Pulido, 2024) y soluciones de recombinación, mediante el uso de nanopartículas que soportan resonancias plasmónicas de superficie localizadas (LSPR) en los modelos ópticos, potenciando la absorción de fotones (Bueno et al., 2024). El manejo de capas de materiales en solución coloidal (propuesto como método de diseño sostenible), con el objetivo de simplificar el reciclaje. Los cometas de optimización: concentradores, filtros, configuradores, compensadores y regenerativos, de diseño biomimético, inspirados en las medusas

(con propiedades bioluminiscentes), con doble membrana de confinamiento para cámaras de aire de geometría configurable, plasma con polarización de carga eléctrica y solución diluida, formulada como lente paramétrica, mediante concentración dinámica de la solución coloidal.

Entre los resultados prácticos se encuentra el diseño de ensayos diseñados para el estudio los principios físicos en aplicaciones RSE.

Objetivos de la práctica:

1. Establecer un procedimiento académico para generar modelos compatibles entre sistemas físicos clásicos y cuánticos, mediante la validación de etapas y estudio de las condiciones de borde.
2. Interpretar los sistemas físicos complejos, como modelos fractales, a través de postulados y métodos de ciencias puras y aplicadas.
3. Reconocer patrones de flujo, energía, resplandor, órbitas de trayectoria, a fin de aplicarlos en la descripción teórica de física moderna y ondas.
4. Identificación de las variables físicas de energía, como operadores matemáticos, en el modelo de interacción de sistemas concatenados.
5. Aplicar progresiones geométricas, secuencias y polinomios característicos en la descripción biomimética de ciencias naturales.

Metodología de los ensayos prácticos

- ✓ Definir una perspectiva práctica para el análisis del sistema.
- ✓ Identificar las variables, según los objetivos de modelado.
- ✓ Establecer un análisis fractal de compensación simétrica, para el modelado de la interferencia entre elementos del conjunto.
- ✓ Ajustar los cambios de variable de simplificación pertinentes.
- ✓ Rediseñar el modelo en función de términos de niveles de abstracción fractal.

Aplicaciones prácticas de Fïsica RSE

- ✓ Terapia de configuración de luz y fotones, mediante patrones de filtros combinados por longitud de onda. Una composición espectral de luz para la reconfiguración de estructuras. Cristales de tiempo y configuración magnética. Diagnóstico por ultrasonido y reconfiguración de los soportes estructurales y tejidos regenerativo.
- ✓ Los estudios experimentales se plantean sobre gemelos digitales, desarrollados con biomimética y descripción en VHDL. Terapia magnética para rehabilitación articular. Láser, para estimulación fotónica de síntesis de proteínas en la formación de tejidos de reparación (Ingeniería de tejidos). Implantes magnéticos intramusculares para la realineación de estructuras ósea, corrección de postura y rehabilitación de movilidad asistida por mecanismos ortopédicos.
- ✓ Ultrasonido, terapia de ondas acústicas para la reparación de tejidos biológicos, regeneración de piezas dentales, etc.
- ✓ Implante de lentes reconfigurables, para la formulación de la composición coloide y los ángulos de incidencia de la luz.
- ✓ Biomimética y Robótica aplicada a la formulación de terapias regenerativas (Figura 4).

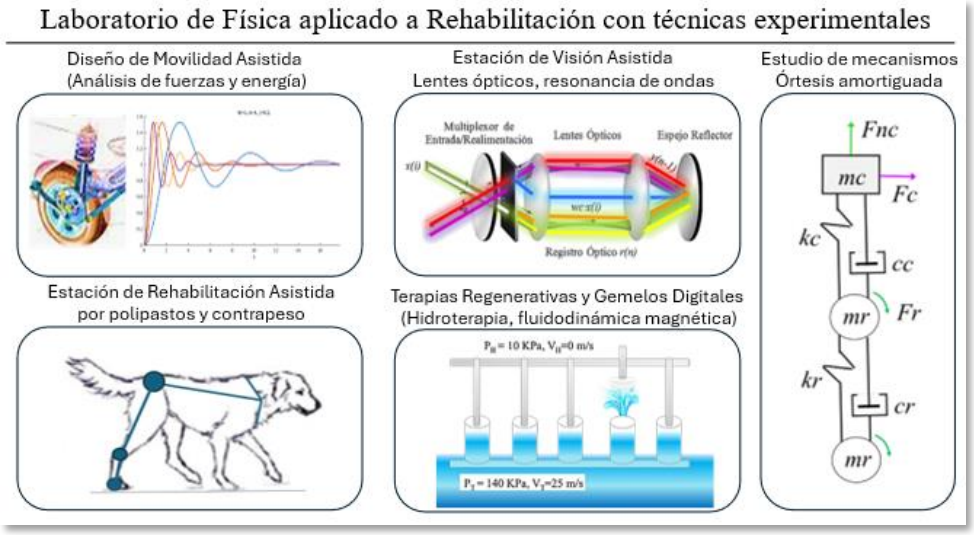

Figura 4. Diseño Conceptual del Laboratorio itinerante de física aplicada en RSE.

- ✓ Mecanismo de polipastos y contrapeso (Figura 5), para la asistencia de ejercicios de rehabilitación de movilidad, el objetivo es disminuir la carga mecánica sobre el sistema óseo, proporcionando seguridad y facilidad para las terapias de recuperación de movilidad.

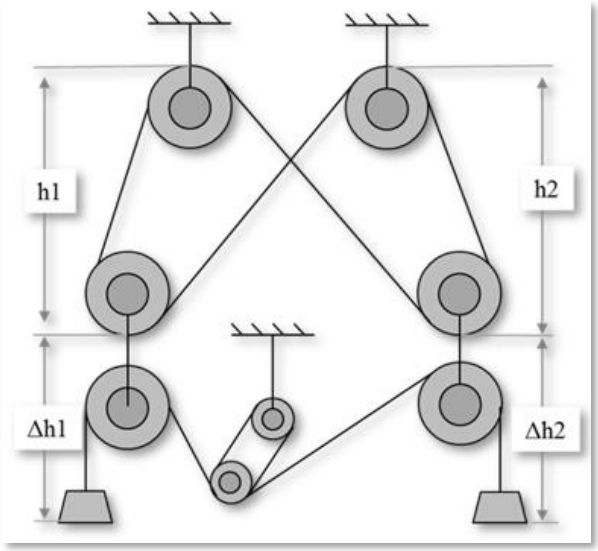

Figura 5. Sistema Físico de Polipastos para fisioterapia.

- ✓ Terapía Neural, mediante técnicas de estimulación mediante ondas de choque, acústicas, fotónicas, presión, etc. en puntos neurálgicos para mitigación del dolor. Cómputo, Simulación y procesamiento de datos sobre Hardware, con ensayos por gemelos digitales programables.
- ✓ Sistema de rehabilitación auto-soportado aplicando elementos de movilidad aérea como cometas, con esquema de soporte tipo arnés ortopédico.

Diseño de ensayos guiados para experimentación remota

1. Utilizar la cámara del celular para registrar la frecuencia de las cuerdas al accionar un instrumento

musical analizando el efecto entre armónicos que se produce en la caja de resonancia y su similitud con las ondas en sistemas de captación de energía.

2. Utilizar un trompo o un lápiz con alerón (colocado a una altura h) para configurar un centro de masa variable y observar el equilibrio dinámico en el movimiento de rotación de las fuerzas de gravedad, fricción e inercia, ¿cómo se puede prolongar el tiempo de giro?, ¿qué efecto tiene colocar otros trompos a girar cerca del objeto de estudio trompo i: según la distancia?,¿fuerza centrífuga del trompo j?, ¿se pueden aplicar los conceptos de conservación de energía angular para optimizar el desempeño de las turbinas de generación eléctrica.
3. Estudiar cómo varía el peso de un yoyo, al recorrer su trayectoria. ¿Por qué si el elemento tiene masa m constante, y la gravedad g es constante, al subir, el peso registrado disminuye? Fuerza elástica de compensación sobre el eje relativo, por estar auto suspendido. ¿Qué aplicaciones prácticas se pueden formular a partir de este experimento? Un sistema de suspensión para órtesis mecánicas y teleféricos auto compensados para ahorro de energía. Desarrollo de un control predictivo sobre modelo MPC para generar la respuesta de compensación sobre el punto de máximo esfuerzo.
4. Estudiar el efecto de la cola de compensación de un papagayo, para el análisis de los principios aerodinámicos, fuerza de sustentación y empuje, así como la interacción con otros elementos, efecto de turbulencia por vórtices programados entre los elementos. Extrapolar los conceptos estudiados para el análisis y diseño de cometas de captación eólica.
5. Se propone la aplicación de un conjunto de espejos para el direccionamiento por geometría proyectiva, aplicando los principios de reflexión de luz incidente. Configurar espejos artificiales sobre superficies de agua con concentración de sal adaptativa al coeficiente de reflexión.

Postulado I. El estudio de los sistemas identificando la relación de principios físicos y modelos matemáticos para soluciones de responsabilidad social ambiental. Se plantea una solución científica para restablecer las condiciones de glaciación natural, donde la geometría proyectiva (área de las matemáticas) se perfila como una alternativa factible.

¿La situación de los glaciares puede ser revertida mediante un parasol programable que mantenga las condiciones de los ecosistemas de montaña? el objetivo sería filtrar la radiación solar incidente a través de un cometa solar proyector, logrando reducir la temperatura y promover las condiciones regenerativas de glaciación, estimulando vórtices eólicos que permitan facilitar zonas de acumulación y aplicando conceptos de ingeniería de tejidos, construir un andamiaje de sustentación del volumen glaciar.

El diseño de un géiser[3] de hielo, con andamiaje de topología configurable (Figura 6), se presenta como un gemelo digital para crear un proceso de regeneración glaciar controlado, basado en proyectos de glaciares artificiales basadas en principios físicos de hidrodinámica y regeneración natural.

[3] Es una fuente a presión, según su naturaleza puede ser un géiser geotérmico, géiser marítimo, donde la acción de las mareas incide en cámaras submarinas de aire comprimido (principio que puede ser aplicado en conversión de energía renovable), o géiser de hielo, formaciones por la acción del viento y las bajas temperaturas, cristalizadas según patrones estructurales específicos de la región.

Figura 6. Física aplicada en soluciones ambientales.

La reglaciación: (1) parasol programable, a través de una cometa que se posiciona limitando la radiación solar incidente sobre la superficie del glaciar, (2) recuperador de temperatura, mediante circuitos de bomba de calor, con un suministro de agua en el que se extrae energía para su cristalización sobre un géiser de hielo con andamiaje de soporte, además de procesos de sublimación inversa (cambio de fase) para conversión de vapor de agua en volumen glaciar, estos mecanismos permitirán la conversión de energía térmica que puede ser transmitida para el suministro de las poblaciones cercanas. (3) Dinámica eólica, la estimulación de vórtices regenerativos para crear la incidencia eólica, a fin de reestablecer las condiciones de glaciación en los espacios a recuperar.

En consideración de los efectos secundarios sobre los ecosistemas de las mantas térmicas directas sobre la superficie de los glaciares, por lo que se plantea la conformación de un arreglo de cometas proyectoras que permitan filtrar la radiación solar para proteger la superficie de hielo del campo actual y crear las condiciones regenerativas, a través de un control de temperatura y técnicas de estimulación de la glaciación, ingeniería de tejidos y otros aspectos de síntesis de las capas glaciares. El modelo de termo mecánica glaciar desarrollado por el GSNCI (Rodríguez, 2014) consta de tres submodelos, Submodelo dinámico basado en sistema de Stokes-conservación de momento lineal y masa:

$$\frac{\partial \sigma_{ij}}{\partial x_j} + \rho g_i = 0, \qquad \frac{\partial u_i}{\partial x_i} = 0$$

Se aplica notación de componentes sobre subíndices, donde σ_{ij} representa el tensor de tensiones de Cauchy, g_i la aceleración de gravedad, ρ la densidad del hielo, u_i la velocidad, x_i posición.

Submodelo térmico (conservación de la energía):

$$k\frac{\partial^2 \theta}{\partial x_i^2} + \rho C_p u_i \frac{\partial \theta}{\partial x_i} + \psi = \rho C_p \frac{\partial \theta}{\partial t}$$

Donde k es la conductancia térmica, C_p calor específico a presión constante, ψ la tasa de calor generado internamente en la unidad de volumen por unidad de tiempo, t el tiempo.

Submodelo de evolución de la superficie libre (caracterización cinemática):

$$\frac{\partial h}{\partial t} = w_S + a - u_S \cdot \nabla_H h$$

Siendo h la altura de la superficie glaciar, w_S, u_S vectores de velocidad, a la tasa de acumulación, ∇_H un gradiente horizontal. De esta manera se puede modelar la dinámica del glaciar, donde la temperatura será correlacionada con la irradiación solar incidente sobre la superficie del glaciar y las tensiones de tensores puede ser relacionada con la energía eólica incidente, como fuerza de sustentación de la superficie glaciar. Estos modelos se complementan con referencia en la ley de flujo de Glen, para el cálculo de viscosidad del hielo glaciar, velocidad de deformación ε, también se plantea un parámetro de densidad respecto a la geometría del glaciar, expresada en forma exponencial: $e^{\mu t}$ que pueda ser integrado respecto al tiempo, para estimar la evolución del proceso de glaciación con control de condiciones incidentes.

Postulado II. *Mecanismos inteligentes para el bienestar y calidad de vida integral*.

El estudio de implementación de técnicas terapéuticas no invasivas, diseño de órtesis aplicando cálculo infinitesimal de las variables estructurales, simulación por métodos numéricos de diferencias finitas y optimización sobre la base de un modelo universal (Milla, 2024), aplicando conceptos de matriz elastomérica, sistemas de amortiguación dinámico para absorción de impacto de forma externa protegiendo las articulaciones y visión asistida con sensores en el rango de ultrasonido, y elementos auxiliares ortopédicos para la protección y movilidad asistida de mascotas.

Postulado III. *Arreglos de optimización de energías renovables*.

Comprende el diseño de lentes de difracción, reflexión, concentración y captación, basado en principios ópticos, resonancia mecánica y entrelazamiento de ondas. Se manejaron teorías fragmentadas para el estudio de grupos y subredes modeladoras, se logra una buena aproximación del caso particular a través de pruebas de validación (*test*), se incluyen condiciones iniciales, condiciones de borde, interferencia inter simbólica simétrica y se unifican mediante debate pedagógico de postulados, para la superposición de modelos compatibles e inclusión de términos de corrección de ecuaciones. Se universaliza el modelo discreto mediante la toma de *n* muestras, con la aproximación de la integral de densidad de energía $\mu(x)$, donde la ecuación modelada para los casos discretos muestra un patrón que corresponde a la función densidad del campo del sistema físico estudiado.

Postulado IV. *No tiene que ser complicado para ser ciencia*.

Lo primero es reconocer los talentos de los innovadores, luego documentar los conocimientos y optimizar las soluciones. Un ejemplo son las sillitas ortopédicas para la movilidad asistida de mascotas, a estas iniciativas se puede sumar la adaptación de mecanismos articulados y acoplamientos con amortiguación, la distribución de carga mecánica de forma óptima, a fin de mejorar la estabilidad estructural. Un poco de ingenio, algo de tecnificación y mucha voluntad, puede lograr grandes cambios, de eso también se trata la ciencia aplicada, de formalizar saberes. Se seleccionan un conjunto de configuraciones experimentales de arreglos concatenados, potencialidades de lugares y gestión circular, para diseñar experimentos prácticos de enseñanza de física, aplicando tecnologías TICs para el diseño de laboratorios de innovación (Sandoval-Ruiz, 2021).

Postulado V. *Ciencia con propósito RSE*. Los sistemas físicos pueden ser interpretados de acuerdo con el observador, la selección de variables físicas y el nivel de abstracción. La simplificación más eficiente corresponde a la generalización del modelo para su ajuste mediante parámetros, enfoques configurables (lente de formulación dinámica) y esto se logra con un método de construcción del pensamiento mediante el debate, análisis y síntesis, siendo las directrices de la pedagogía científica. Tal como enseñar valores es la base de la educación, un modelador requiere contar con métodos de aproximación basada en criterios de sostenibilidad, estabilidad y eficiencia, priorizando entre estos principios de protección ambiental.

Teoría de compensación simétrica. La ecuación del modelo físico generalizado debe contemplar un término de compensación por simetría (Figura 7), para regeneración energética.

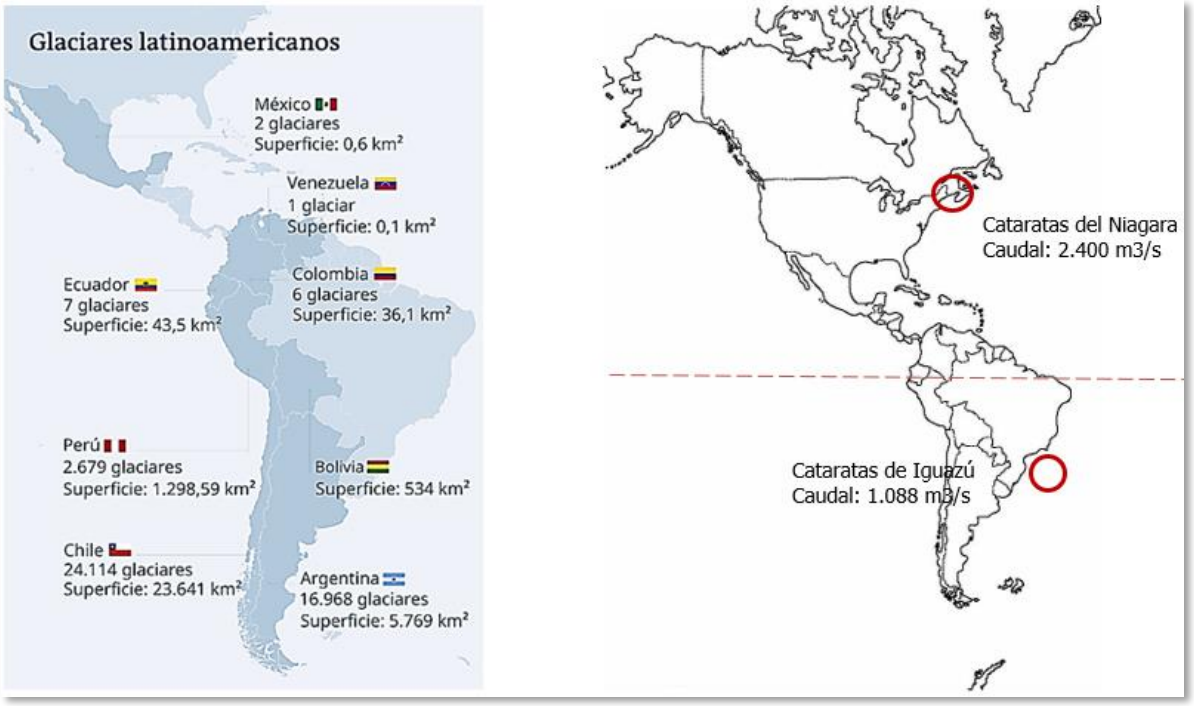

Figura 7. Laboratorio itinerante de física aplicada al estudio de compensación simétrica.

De esta manera, se logra abordar el análisis de compatibilidad del estudio de los mecanismos de estabilización giroscópicos, independiente de la escala con sistemas físicos macroscópicos, identificando la compensación simétrica de dos fuerzas equivalente que se anulan por su simetría, respecto a un eje ecuatorial de referencia, por el sentido de giro definido por efecto Coriolis. Lo que permite sustentar las ecuaciones físicas propuestas en el modelo LFSR (Sandoval-Ruiz, 2024), en el que se incorpora un término de compensación por interacción de elementos distribuidos como generadores de vórtices, tanto en teorías de fluidodinámica cuántica, como microsistemas aplicados a energías renovables.

La biomimética y gemelos digitales son herramientas para desarrollo sostenible en el ámbito de las ciencias físicas, matemáticas y naturales.

Conclusiones

Gracias al estudio realizado, se logra establecer un método formulación de proyectos de responsabilidad ambiental, para motivar la búsqueda de soluciones sostenibles, sin condicionar el alcance de la investigación científica, a través del reconocimiento de patrones fractales en los modelos físicos, sistemas dinámicos y ondas, donde se plantea como principios:

Deducir una técnica de modelado matemático, éste puede ser desarrollado de forma eficiente por algoritmos, pero es un factor importante la formulación de un enfoque por parte del científico, bajo criterios de empatía y responsabilidad ambiental en diseños.

Incluir un término de holgura, es una técnica pedagógica de deducir un modelo a partir del reconocimiento de patrones y reconstrucción de conocimientos con criterios de sostenibilidad y responsabilidad ambiental. Observar los sistemas físicos de manera objetiva, esto definiendo postulados, como parte de una técnica de debate, donde el objetivo es exponer las ideas desde diversas ópticas y sintetizar el modelo de forma descriptiva, dentro de una arquitectura de base.

Sistematizar la aplicación de un patrón de geometría simétrica, como elemento de compensación, cuyo valor fundamental radica en la oportunidad de definir un equilibrio dinámico en la conservación de la energía de los sistemas, dando lugar a la mitigación de impacto ambiental.

Referencias bibliográficas

Bueno, J., Carretero-Palacios, S., & Anaya, M. (2024). Efectos plasmónicos sinérgicos de campo cercano y lejano para la optimización de celdas solares tándem de Perovskita. *Revista de la sociedad española de materiales, 8*(2), 26-29.

Chicaiza, W. D., Gómez, J., Sánchez, A. J., & Escaño, J. M. (2024). El Gemelo Digital y su aplicación en la Automática. *Revista Iberoamericana de Automática e Informática industrial, 21*(2), 91-115.

Chiliquinga, R. R., Rodríguez, K. L., Luje, D. I., & Pucha, O. I. (2024). Desarrollo de habilidades del siglo XXI a través de la educación STEM. *Revista Imaginario Social, 7*(2). https://doi.org/10.59155/is.v7i2.191

Cruz, M. F. R., Pavin, C. S., Silva, E. P., de Moura, I. M., Garcia, G., Silva, M. P., ... & da Silva Neto, J. F. (2024). Reabilitação animal através da utilização de órteses, proteses e terapias complementares. *Caderno Pedagógico, 21*(5), e4318-e4318.

Echeverría, M. P. P., Pozo, J. I., & Cabellos, B. (2024). ¿Ayudan las tic a una enseñanza más centrada en el estudiante en las materias STEM?. *Investigações em Ensino de Ciências, 29*(1), 396-409.

Guzmán Jiménez, J. J., & Aguirre Salguero, G. P. (2024). *Diseño arquitectónico de un centro de rehabilitación ecoamigable para animales en situación de calle en la ciudad de Guayaquil* (Bachelor's tesis), Guayaquil: ULVR, 2024.

Marín, H. A. (2022). Transformada Cuántica de Fourier. Revista Innovación Digital y Desarrollo Sostenible.*IDS, 2*(2), 9-18.

Milla Parramón, A. (2024). *Estudio, diseño y montaje de sillas de ruedas universales para perros.* (Bachelor's tesis), Universitat Politècnica de Catalunya.

Rodríguez, C. (2014). *Integración de modelos numéricos de glaciares y procesado de datos de georradar en un sistema de información geográfica* (Doctoral dissertation), E.T.S.I. Telecomunicación (UPM).

Sandoval-Ruiz, C. (2024). xyz Modelo de optimización de arreglos de cometas captadoras de energías sostenibles. *Revista Técnica de la Facultad de Ingeniería Universidad del Zulia, 46*(2), e244701. https://doi.org/10.22209/rt.v47a01

Sandoval-Ruiz, C. (2024). ZPF para arreglo de Proyección de Onda: φ-LFSR en Modelado Fp[x]/f(x) de Sistemas de energías renovables». *Revista de la Universidad del Zulia, 15*(42), 281-305. https://doi.org/10.46925//rdluz.42.16

Sandoval-Ruiz, C. (2024). e-KiteLab: investigación en física aplicada para mantenimiento y optimización de sistemas de energías renovables. *Revista Investigación & Desarrollo, 24*(1), 95-105. https://doi.org/10.23881/idupbo.024.1-8i

Sandoval-Ruiz, C. (2024). Ω – Vórtices y acoplamientos resonantes en modelo de patrón de flujo toroidal regenerativo mediante física moderna y ondas. *Calibre Revista Brasiliense de Engenharia e Física Aplicada, 9*(1), pp.1-20. https://doi.org/10.5281/zenodo.13926923

Sandoval-Ruiz, C. (2024). Operador matemático para caracterización y optimización de etapas de sistemas físicos. *Revista Colegiada de Ciencia, 5*(2), 88–98. https://doi.org/10.48204/j.colegiada.v5n2.a5029

Sandoval-Ruiz, C. (2023). YPR-alignment angles for wind energy harvesting kite arrangement: α,β,γ-coefficients for control and maintenance of regenerative flow patterns. *UCSA, 10*(3), 3–15. https://doi.org/10.18004/ucsa/2409-8752/2023.010.03.003%20%20

Sandoval-Ruiz, C. (2023). Biomimética Aplicada a Modelos de Sistemas de Energías Renovables Reconfigurables Basados en Estructuras Autosimilares. *Revista Técnica De La Facultad De Ingeniería. Universidad Del Zulia*, *46*(1), e234602. https://doi.org/10.22209/rt.v46a02

Sandoval-Ruiz, C. (2021). Capacitación remota en competencias técnicas en el marco de la ambientalización de la Ingeniería La formación con herramientas TICs para soporte del Teletrabajo. *Revista Eduweb, 15*(2), 10-21. https://doi.org/10.46502/issn.1856-7576/2021.15.02.1

Sandoval-Ruiz, C. (2020). Proyecto Cometa Solar–CS para optimización de sistemas fotovoltaicos. *Universidad Ciencia y Tecnología, 24*(100), 74-87.

Torres Suárez, N. (2023). *Realización de la transformada cuántica de Fourier utilizando una FPGA*. (Trabajo de Grado). Universidad Politécnica de Madrid.

Tuyarot, D. E., & Arriassecq, I. (2015). Enseñanza de la física universitaria a través de proyectos: el motor de Stirling. *Revista de enseñanza de la física, 27*, 447-452.

Valero, J., Bonilla, Y., Sandoval, C., & Duque, C. (2012). Sistema de control de una silla de ruedas para seguimiento automático. In *Memorias del Congreso ASME USB* (pp. 1-7).

Xahuentitla, D. T., & Pulido, J. J. A. (2024). Celdas solares avanzadas: el papel crucial de las tecnologías TÁNDEM. *RD-ICUAP, 10*, 179-193.

Yan, G., Wei, J., Apodaca, E., Choi, S., Eng, P. J., Stubbs, J. E., ... & Liu, C. (2024). Identifying critical features of iron phosphate particle for lithium preference. *Nature Communications, 15*(1), 4859.

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.2
Cómo citar:
Sequera Torres, N.J, & Sequera Torres, N.J. (2024). Metadimensionalidad de las tecnologías de información y comunicación en la educación médica. *Revista Eduweb*, *18*(4), 26-34. https://doi.org/10.46502/issn.1856-7576/2024.18.04.2

Metadimensionalidad de las tecnologías de información y comunicación en la educación médica

Metadimensionality of information and communication technologies in medical education

Nahir José Sequera Torres
https://orcid.org/0000-0002-3754-0241
nahirjose@gmail.com
Universidad de Carabobo, Sede Aragua. Facultad de Ciencias de la Salud. Escuela de Bioanálisis "Profa. Omaira Figueroa H.". Departamento Socioepidemiológico, Maracay, Venezuela.
Naira José Sequera Torres
https://orcid.org/0009-0000-5869-6969
nairajose@hotmail.com
Universidad de Carabobo, Sede Aragua. Facultad de Ciencias de la Salud. Escuela de Bioanálisis "Profa. Omaira Figueroa H.". Departamento Socioepidemiológico, Maracay, Venezuela.

Recibido: 13/08/24
Aceptado: 29/10/24

Resumen

En la tecnología educativa para la formación de los estudiantes de medicina, dentro del subsistema universitario, se va cerrando una brecha en el empleo de las tecnologías de cuarta dimensión como una nueva experiencia humana o, una nueva manera de formación, a través de la representación del ciberespacio. La metadimensionalidad de las TIC sumergen al usuario y lo hacen parte del proceso, dicho de otra manera, la cuarta dimensión tiene un grado de realidad en la educación médica por medio de visores tridimensionales y tetradimensionales del cuerpo humano. Con la fenomenología interpretativa como enfoque, se da paso al conocimiento para percibir una realidad en la educación médica del mañana, adoptándose como método el círculo hermenéutico que va del todo a las partes y de las partes al todo. Metadimensionalidad de las TIC, significa más allá de en cuanto a dimensión, para integrar plataformas digitales en una, representadas éstas por los metaversos, la bioimpresion, la georreferenciación satelital, la realidad aumentada, la realidad virtual, la proyección holográfica, entre otras tecnologías emergentes. Así el estudiante en su proceso de formación complementa con estos circuitos de tecnología, para un aprendizaje significativo en Ciencias de la Salud.

Palabras Clave: cuarta dimensión, educación médica, metadimensionalidad, tecnologías emergentes, tridimensional.

Abstract

In educational technology for the training of medical students, within the university subsystem, a gap is closing in the use of fourth-dimensional technologies as a new human experience or a new way of training, through the representation of cyberspace. The metadimensionality of ICTs immerses the user and makes

him part of the process; in other words, the fourth dimension has a degree of reality in medical education through three-dimensional and four-dimensional viewers of the human body. With interpretive phenomenology as an approach, knowledge is given way to perceive a reality in the medical education of tomorrow, adopting as a method the hermeneutic circle that goes from the whole to the parts and from the parts to the whole. Metadimensionality of ICTs means beyond dimension, to integrate digital platforms into one, represented by metaverses, bioprinting, satellite georeferencing, augmented reality, virtual reality, holographic projection, among other emerging technologies. In this way, the student complements his training process with these technology circuits, for a significant learning in Health Sciences.

Keywords: fourth dimension, medical education, metadimensionality, emerging technologies, three-dimensional.

Introducción

La Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO, 1998), al expresar que "las nuevas tecnologías constituyen un desafío a los conceptos tradicionales de enseñanza y aprendizaje", reconoce que estamos haciendo frente a unos avances tecnológicos que permiten al estudiante en formación, permanecer activo dentro de su rol como permanente receptor de conocimientos.

En el campo de las Ciencias de la Salud, el desenvolvimiento de la trayectoria del discente de medicina, visto desde la fenomenología, como corriente que trata la naturaleza y las relaciones del ser, proporcionan un valor agregado al educando en cualquier área del saber. Esto se traslada con la medicina basada en evidencias (MBE) para que el estudiante de medicina, de acuerdo con Málaga & Sánchez Mejía (2009) establezca como "eje principal de actuación y como razón de ser él o la paciente" (p. 193). Hoy día los estudiantes de medicina no son los mismos, la forma en que enfrentan el conocimiento es muy diferente, cuentan con información sin requerir constantemente del profesor, debaten las nuevas tendencias en el ejercicio del razonamiento clínico, basan su aprendizaje en ambientes de navegación, para ubicarse en distintos escenarios de la realidad, virtualidad y presencialidad.

De allí que el propósito de este ensayo es visibilizar algunas de estas tecnologías emergentes que transforman la educación médica, estructurándose en una sección que esboza primeramente la metadimensionalidad de las tecnologías de información y comunicación, concepción que no está claramente definida o explorada en profundidad, pero que significa *más allá* o *encima de*, ofreciendo una visión distinta de los marcos tradicionales de espacio y tiempo, por ser un contexto donde se está inmerso en él.

Luego se abordan algunas de las tecnologías consideradas metadimensionales, resumiendo cada una de ellas y su implicación en la educación médica, haciendo posibles espacios inmersivos, donde el estudiante es el principal partícipe de los mismos, por último, se expone un cuerpo de reflexiones y conclusiones aproximadas, para dejar entrever perspectivas futuras en un área tan sensible como lo es la educación médica y finalmente las referencias bibliográficas consultadas.

Ejemplo de estas tecnologías incluyen los metaversos, que proporcionan interfaces tridimensionales para el aprendizaje de la fisiología humana, también se encuentra la impresión de estructuras humanas y órganos en tercera dimensión o bioimpresión, preparando al estudiante en su fase experimental de forma previa, sigue la georreferenciación satelital como técnica de ubicación geográfica por tecnología GPS (sistema de posicionamiento global), para integrar datos de salud de una comunidad, monitoreo de pacientes en prácticas médicas o vigilancia endémica, epidémica o pandémica según sea el caso.

Le sigue la realidad aumentada que permite superponer imágenes ficticias sobre imágenes reales para una mejor comprensión y explicación de la anatomía humana, así como también la realidad virtual para crear espacios inmersivos como el quirófano, que hará que el discente adquiera experiencia práctica y confianza antes de enfrentarse a casos clínicos reales y por último la holografía, que si bien es poca

conocida aun en América Latina e inclusive a nivel mundial, recrea objetos que se pueden apreciar mejor para un estudio analítico y minucioso de un cuerpo humano que físicamente no existe.

Metadimensionalidad de las Tecnologías de Información y Comunicación

Tratando de profundizar en el título que concierne, en la metadimensionalidad de las tecnologías de información y comunicación, se debe iniciar por el significado del prefijo meta, en una de sus acepciones que significa *después de* y en la formación de palabras uno de sus significados es *más allá*. La metadimensionalidad, es definida por Arancibia Herrera, M., & Pérez San Martín (2002) como "la capacidad de integrar varios medios en uno solo. Las plataformas digitales y tecnológicas se constituyen en el soporte que reúne y ofrece esta característica" (p. 160).

En cuanto a dimensión, se refiere a la longitud, extensión o volumen, pero cuando se expresan en dimensiones más altas, parafraseando a Kaku (2011), se define como metadimensionalidad la aprehensión de cuatro o más dimensiones, con un nuevo método de representación gráfica del espacio euclídeo, que se le denomina también sistema tetratriédrico. El tetraedro, es definido por Geolab (2018), como "poliedro de cuatro caras iguales que son triángulos equiláteros" (p. 8). Ahora bien, esta geometría visualizada en el plano sagital del cuerpo humano vista desde los cuatro costados, hace pensar que enseñar anatomía resultaría atractivo si se cuenta con la magnífica tecnología que hoy existe para ese propósito.

Desde el mundo virtual de la tecnología, vista como una realidad intangible, que no es otra cosa que hacer posible un mundo que no es real, se puede navegar y explorar. El talante de este mundo es el ciberespacio definido por Gibson (2019) como "una representación gráfica de los datos abstraídos de los bancos de cada computador en el sistema humano" (p. 87) basado en la linealidad del texto y bidimensionalidad de las imágenes planas. En la actualidad, la incorporación de las tecnologías de información y comunicación en la formación del discente de Ciencias de la Salud, se basa en un ciberespacio con elementos secuenciales (hipertexto: páginas web) y audiovisuales (hipermedia: gráficos, sonido, vídeo, animaciones) que tienen por objeto una finalidad educativa.

El camino recorrido de una para otra página de la World Wide Web en las ventanas de los navegadores, hace posible experimentar la espacialidad en la red Internet, desde el punto de vista del sujeto que navega, la transición de una para otra página es percibida como un movimiento del o en el ciberespacio, donde de acuerdo a Fragoso (2001) "cada vez que selecciona un link, al mismo tiempo, el usuario mueve el ciberespacio y se mueve de modo que queda delante de la representación bidimensional de un elemento diferente" (p. 4).

A través del tiempo, este ciberespacio ha trascendido a lo que se apunta como una estructura espacial más compleja, el hiperespacio, definido por Fragoso (2001) como "espacios con más de tres dimensiones" (p. 5), es aquí donde una cuarta dimensión constituye una realidad metadimensional. Desde esta nueva dimensión, se ambiciona tecnológicamente desde la matemática y geometría como ciencias cuantitativas, la posibilidad de representar un hiperespacio, que de acuerdo con lo expuesto por Llorens (2016) "es una proyección ortogonal de las figuras sobre cuatro hiperplanos de proyección, perpendiculares entre sí, obteniendo un modelo gráfico, fiel e interpretable, del espacio tetradimensional euclídeo" (p. 13).

Matemáticamente en la geometría euclidiana esto se explica de acuerdo con Mandelbrot y et al. (1984) como "un punto tiene dimensión cero, una línea tiene una dimensión (longitud), una superficie tiene dos dimensiones (longitud y anchura) y un volumen tiene tres dimensiones (longitud, anchura y altura)" (p. 176). Desde la realidad tetradimensional, se incluye o se agrega el tiempo en la cuarta dimensión, la cual sí bien no es posible visualizar sí se puede representar con figuras geométricas como el hipercubo, análogo a un cubo en tres dimensiones el cual según Mandelbrot y et al. (1984) "es una figura formada por dos cubos tridimensionales, desplazados en un cuarto eje dimensional de cuatro dimensiones

espaciales" (p. 179), comparable desde la fisiología, con el Hombre Vitruviano propuesto por Leonardo da Vinci.

Este punto de inflexión y la apertura de nuevas tecnologías supondrían una cosmovisión holística para la compresión del cuerpo humano en todo su esplendor, donde fácilmente es posible reconocer el paradigma de la complejidad, por la capacidad de este pensamiento de comprender distintas realidades. Según Domínguez y et al. (2017) en la película The Matrix de los hermanos Wachowski, se evidencia "la situación antropológica, mental y ética al que se enfrenta el sujeto en la sociedad de la información y el conocimiento" (p. 188). Se presenta así, un proceso inmersivo, que, de acuerdo con la Real Academia Española, "hace vivir al espectador una realidad virtual como si fuera auténtica", lo cual resulta beneficioso para los estudiantes de medicina que permanentemente se sienten atraídos por la sensación de estar presentes o inmersos en mundos digitales.

Tecnologías metadimensionales en la formación de los discentes de medicina

Una de estas tecnologías metadimensionales para una nueva concepción del aprendizaje de la medicina, son los metauniversos, llamados así originalmente para referirse a lo que va más allá del universo que actualmente es conocido por todos. Al contraer el sustantivo universo con el prefijo meta se forma la palabra metaverso que se ha hecho tan popular hoy en día y que es un acrónimo muy conocido por todos, incluyendo sus sinónimos megaverso, multiverso y hasta Tierra digital.

Esta palabra apareció por primera vez en la novela *Snowcrash* de ciencia ficción cuyo autor es *Neal Stepehenson* y desde entonces ha sido acuñado en películas de este género y con mayor énfasis en los videojuegos, es un neologismo muy utilizado no definido por la Real Academia Española, que sin embargo lo asoma como relativo a un universo digital. De acuerdo con Sandua (2024) "metaverso es un espacio virtual colectivo que surge de la fusión de la realidad física virtualmente mejorada, la realidad aumentada e Internet" (p. 14).

Desde esta perspectiva, el metaverso es una tecnología metadimensional en cuyos espacios inmersivos simulados se recrea un ecosistema de realidades para ejercer múltiples actividades sin límite y fronteras, pero con características inamovibles como lo son la corporeidad, la interactividad y persistencia; por ello es una tecnología novedosa en los espacios de aprendizaje de la medicina, convirtiéndose en un lugar formativo o pedagógico basado en solución de problemas.

Para Sandua (2024) "este entorno inmersivo permite que las interacciones sociales sean más dinámicas, atractivas y multidimensionales, permitiendo a los usuarios interactuar no solo mediante texto o videos, sino también mediante avatares, entornos virtuales e incluso diapositivas de realidad virtual" (p. 17).

Gutiérrez-Cirlos y et al. (2023) ponen de manifiesto el estudio de algunas asignaturas de la medicina a través de cardioversos, orthoversos, rehabversos y neuroversos, por decir algunos metaversos dirigidos a los estudiantes de medicina en donde se pueden recrear escenas complejas e interactuar con especialistas en el área, como también suceden en *Second Life*, uno de los metaversos más conocidos por desarrollar actividades de formación y educación en Ciencias de la Salud.

No solo la realidad física fusionada con la virtualidad digital se visualiza en los metaversos, sino también en una tecnología capaz de trascender las limitaciones hasta ahora conocidas, como lo es la fabricación de órganos a partir de tejidos naturales. Se trata de la bioimpresión, que, si bien es una tecnología futurista, desde hace tiempo ha estado presente para prestar un servicio a la medicina regenerativa a través de la fabricación de estructuras biológicas mediante células.

Investigaciones como las de Dhawan et al. (2019) definen "la bioimpresión como un proceso de construcción capa por capa de materiales vivos y no vivos, basados en un diseño por computador para producir estructuras de bioingeniería y algunos estudios biológicos" (p. 3) con un alto impacto positivo en

los estudiantes de medicina, en asignaturas donde la bioimpresión es de gran utilidad, como lo es anatomía e histología.

El fin educativo de la bioimpresión para los discentes de medicina en asignaturas como éstas, permite a ese estudiante afianzar los conocimientos adquiridos en los tejidos y órganos de mayor complejidad impactando en su pericia, entrenamiento y desempeño cuando sea un futuro profesional de Ciencias de la Salud. Para García Villegas & Vidarte Pastrana (2019) "las aplicaciones de bioimpresión en los últimos años se han ampliado debido a la creciente tecnología e investigación de los biomateriales, biotintas y técnicas de bioimpresión a utilizar" (p. 12). Por medio de la bioimpresión 3D se puede crear en un futuro próximo órganos que se implanten para salvar vidas.

Otra de las tecnologías de información y comunicación que va más allá de las dimensiones conocidas, es la georreferencia satelital que ha hallado en el campo de la salud extraordinarias aplicaciones, no obstante, debe distinguirse de la geolocalización que solo sigue trayectorias, porque la georreferenciación, es capaz de triangular y ubicar en un sistema de coordenadas. De acuerdo con Vivas (2012) "la georreferenciación ha dado luz a los Sistemas de Información Geográficos (SIG), que suponen un paso adelante no sólo en ubicación de estos pacientes o posibles pacientes, sino que permiten superponer capas de variables en un mismo segmento de territorio" (p. 56).

Esta tecnología metadimensional cuenta con imágenes en tiempo real, que se sirve de los sistemas de posicionamiento global y de aplicaciones como Google Earth que soporta datos geoespaciales tridimensionales. El aporte de la georreferenciación a la salud pública ha sido destacado por la Organización Mundial de la Salud permitiendo según Carvalho y OPAS (2006) citado por Betancurth Loaiza et al. (2023) "la ubicación espaciotemporal de los eventos", en otras palabras, no solo se georrerencia la enfermedad, sino también el sitio de cada evento.

He aquí la importancia de georreferenciar la ubicación de aquellas comunidades donde se presenten focos endémicos y/o epidémicos y hasta pandémicos, que puedan ser controlados a tiempo bajo esquemas de repuestas oportunas de acuerdo a las características etiológicas, clínicas y sociodemográficas, generando posibilidades de visualización de aprendizaje en lo que respecta a la atención primaria con la cooperación de los estudiantes de medicina, en asignaturas como el servicio comunitario u afines, diseñando metodologías para la recopilación de datos sociosanitarios.

Una de las tecnologías emergentes que no puede faltar es la realidad aumentada, considerada una tecnología disruptiva que rompe con los esquemas convencionales, es definida por Otegui (2017) como la combinación de "elementos del mundo real con el mundo virtual…a través de un dispositivo tecnológico que permita dicha interacción" (p. 173). Funciona con una tríada tecnológica básica resumida por Ramallal et al., (2024) en "una cámara (input), un aumentador dependiente de un hardware (renderizador 3D, audio), y una pantalla, así como de manera recurrente el uso de altavoces (output)" (p. 3).

Fácilmente se puede entender que la realidad aumentada fusiona información física en tiempo real con información virtual, siendo el tipo de realidad aumentada más utilizada en la educación la de marcadores de posición, que en palabras similares a las de Cabero Almenara y et al. (2018) se trata de relacionar una imagen, vídeo o animación 3D a un marcador impreso generado en un software específico, de manera que al visualizar el marcador con un dispositivo tecnológico se activarán los objetos virtuales en la pantalla del móvil, cambiando de posición y perspectiva.

Así es como la realidad aumentada se ha ido incorporando poco a poco en el ámbito educativo de la medicina como una opción novedosa, que proporciona clases más dinámicas y enriquecedoras y constituye así el escenario perfecto para que el estudiante de medicina, coloque a prueba el pensamiento crítico a través de la "representación visual (real-virtual) de conceptos teóricos complejos como la anatomía del cuerpo humano" (p. 10), de acuerdo con Harun y Mantri (2020).

Con esta herramienta inmersiva, los discentes de medicina pueden visualizar en la pantalla de sus dispositivos tecnológicos diferentes partes del cuerpo o de la anatomía humana en tres dimensiones, (lo cual no es fácil de acceder en la vida real) pudiendo moverlos en diferentes direcciones y así aprender técnicas específicas del proceso médico.

También la realidad virtual como tecnología emergente y/o disruptiva se ha ido perfilando como una herramienta motivadora, que capta la atención del estudiante de esta área y beneficia la adquisición de sus conocimientos de forma novedosa, por lo general, tiende a confundirse con la realidad aumentada, debido a que ambas emplean modelos virtuales gráficos tridimensionales, pero se diferencian plenamente dado que la realidad virtual reemplaza por completo la realidad física por la virtualidad, mientras que en la realidad aumentada se complementan.

Para contextualizar en sí, la definición de realidad virtual, acudimos a Otegui (2017) quien la define como un sistema informático "usado para crear un mundo artificial, generado por un ordenador o por una cámara virtual que permite al usuario visualizar, manipular e interactuar con ese mundo, en tiempo real, a través de un dispositivo que permita su presencia en él" (p. 181), en esto, también se diferencia de la realidad aumentada porque la inmersión del usuario es total, mientras que en la aumentada es parcial.

Este emplazamiento total de la realidad por la virtualidad ha traído consigo numerosas ventajas que posicionan a la realidad virtual como una de las herramientas más utilizada en la educación, con mayor sensibilidad en la enseñanza de la medicina, abriendo paso a la simulación de órganos sanos o enfermos, la vista transeccional del cuerpo entero de forma tridimensional, relación entre las estructuras anatómicas, disecciones, biopsias, anatomías complejas, suturas, entre otros ejemplos, sin constituir un reemplazo de la enseñanza tradicional, sino un complemento en la formación del discente.

De hecho, para Castro Alonso, P. L., & Rodriguez-Florido (2022), "la progresiva introducción de la realidad virtual a la docencia reglada en Ciencias de la Salud demuestra que se trata de una tecnología idónea, los beneficios que aporta son tan variados que tienen poca comparación con otras tecnologías introducidas a lo largo de la historia" (p. 2), en la mayoría de las investigaciones realizadas sobre el tema, se asegura que la implementación de la realidad virtual mejora la calidad educativa considerablemente.

Y finalmente, corresponde el turno de mencionar una tecnología metadimensional poco conocida, por los factores tecnológicos, económicos y de accesibilidad que la circundan, denominada holografía u holograma, que etimológicamente viene del griego holos, que significa completo y cuyo principio básico es la refractación de las ondas de luz, originando una visión tridimensional de los objetos. El diccionario Real Academia Española (2003) la define como "una técnica fotográfica que, mediante iluminación por láser, permite obtener imágenes tridimensionales en color", dando la sensación de que el objeto realmente está ahí.

Aun con la tecnología existente, la holografía no ha alcanzado su máximo auge por las implicaciones en sí misma para su desarrollo, no obstante, se han creado dispositivos y programas que emulan imágenes holográficas como Microsoft HoloLens 2, un casco tipificado como realidad mixta (realidad aumentada y realidad virtual), ya descritas anteriormente. Para Orcos (2017), el holograma se describiría como la reproducción “en tres dimensiones que proporcionan una sensación de realidad similar a la que percibimos con nuestros ojos cuando miramos a la realidad” (p.4), y esto es precisamente lo que se visualiza con este innovador dispositivo.

Su aplicación aporta soluciones en diversas áreas donde es aplicado, siendo la educación la que más se beneficia de ella, como lo expone la página web de Microsoft.com (2023) al señalar que se "revoluciona el plan de estudios con planes de lecciones prácticas que transmiten conceptos complejos en 3D. Con HoloLens 2, los alumnos pueden aprender de forma práctica desde cualquier lugar con evaluaciones e instrucciones holográficas" (p. 3), y así de la educación a la educación médica el salto es pírrico; en palabras similares a las de esta corporación tecnológica multinacional, se transforman las imágenes

médicas en hologramas 3D, obteniendo una perspectiva más amplia de la anatomía y patología del paciente, haciendo que la formación médica sea interactiva e inmersiva.

En la actualidad, Holoconnects (2023) ofrece a las áreas de las comunicaciones, el entretenimiento y la educación, entre otros, servicios de "soluciones holográficas 3D para interactuar con el cliente en tiempo real utilizando una capacidad de respuesta programada o impulsada por inteligencia artificial con presentaciones llamativas" (p. 2), esta empresa ofrece cajas holográficas (holobox) formadas por displays holográficos 3D en tamaño real. Su tecnología en la telesalud empleando "ondas de luz y rayos láser para crear imágenes tridimensionales u hologramas que parecen flotar en el espacio" (p. 1) pudiéndose ver dicha imagen desde diferentes ángulos y así dar diagnósticos más precisos también de forma remota, siendo el Hospital Regional Crescent en Texas, unas de las primeras instituciones del sector sanitario en utilizar esta tecnología holográfica tridimensional para mejorar la atención al paciente.

A manera de reflexión

Por metadimensionalidad de las tecnologías de información y comunicación en la educación médica, se ha querido agrupar desde el metaverso hasta la holografía, pasando por la bioimpresión, la georeferencia satelital, realidad aumentada y realidad virtual, solo por mencionar algunas arquitecturas tecnológicas tridimensionales. De manera más informal, la génesis de la metadimensionalidad, es como si se tratase de dimensión sobre dimensión, no medibles ni observables en el modelo estándar de la física de partículas, aunque se pueden describir matemáticamente por medio de simulaciones, modelamientos o proyecciones que busca replicar el mundo real, como sucede con las TIC antes mencionadas, haciéndose cada vez más realista y algunas de ellas inmersivas en un mundo virtual.

Cada una de estas tecnologías, de acuerdo con Cabero Almenara y et al. (2018) "presentan una serie de características que las hacen especialmente adecuadas para la enseñanza, entre éstas se encuentran su inmaterialidad…ruptura de la linealidad expresiva, elevados parámetros de calidad de imagen y sonido…diversidad e innovación" (p. 2) constituyéndose en medios que facilitan la nueva concepción del aprendizaje.

Las arquitecturas tecnológicas aquí mencionadas se podrían concentrar en aquellas con dimensiones que replican el mundo real (bioimpresión, georreferenciación satelital, holografía) y las tecnologías de mundos inmersivos con una dimensionalidad desafiante a la naturaleza de la realidad (metaversos, realidad aumentada, realidad virtual).

Cada una de estas tecnologías están transformando específicamente a la formación médica, al educar de manera diferente a la habitual, en este sentido, propician recursos de apoyo a los discentes de medicina que se desenvuelven en una sociedad del conocimiento que para Domínguez y et al. (2017), demanda "la utilización de nuevas tecnologías para aprender a aprender y a desaprender" (p.196).

Es así como la bioimpresión ha tenido un impacto significativo al crear tejidos, órganos, implantes para estudiar anatomía sin necesidad de cirugías, por su parte la georreferenciación satelital enriquecen al estudiante en lo que respecta a las variables fisiológicas para darle una visión espacial de determinada patología, al georreferenciar una enfermedad con plataformas geomáticas, mientras la holografía presta mayor seguridad y confianza al realizar procedimientos precisos en imágenes de alta resolución antes de llevarlas a cabo en pacientes reales.

Por su parte, los metaversos propician consultas médicas a distancia y salas de terapia y apoyo que servirían de práctica médica al estudiante, con la realidad aumentada, se interactúa con la anatomía humana, por ejemplo, se ha podido proyectar los vasos sanguíneos sobre la propia piel del paciente y la realidad virtual permite ver partes del cuerpo humano en 360º grados, creándose avatares para el entrenamiento quirúrgico en un simulador de realidad virtual y así crear escenarios seguros de entrenamiento para los discentes. Desde el punto de vista psicosocial el discente adquiere confianza, en

un entorno seguro, desenvolviéndose con mayor seguridad y convicción, enriqueciendo su abanico de experiencia para proporcionar a futuro soluciones emergentes certeras.

Ante estas tendencias, ha de preguntarse sí existen implicaciones para el futuro de la educación médica, como lo ha expresado válidamente Montes de Oca (2017), al manifestar que "la formación de los médicos del futuro y más cerca de lo pensado, se hará con métodos virtuales y donde se perderá la relación de empatía del médico o del paciente" (p. 21), no obstante, el estudiante de un área tan sutil como la medicina, define un perfil que emplea la tecnología como una aliada e importante recurso complementario y de apoyo, que jamás sustituirá habilidades y experticias en su futuro desempeño como profesional de las Ciencias de la Salud.

Conclusiones

Son numerosas las investigaciones sobre la trascendencia de la tecnología en el ámbito académico con vital repercusión en la educación. Tanto en la actualidad como en el futuro, los estudiantes de pregrado en la carrera de medicina, se están formando con recursos nuevos, impensables tiempos atrás, ante lo cual Cataldi, Lage y Dominghini (2013) expresan que "el uso de las TIC debe integrarse a un cambio de paradigma que propicien la innovación y creatividad" (p. 12), en donde se destaca el protagonismo del discente ante las nuevas exigencias y reorientación de su aprendizaje en las distintas aristas clínicas y humanas.

La metadimensionalidad de las TIC, hacen alusión a una postrealidad, donde una cuarta dimensión constituye una realidad metadimensional de las representaciones virtuales del cuerpo humano en todo su esplendor para que los discentes adquieran habilidades y destrezas en entornos seguros, sin ningún tipo de riesgo, traduciéndose en un aprendizaje significativo, complementario a las enseñanzas dadas por sus profesores conductores en su proceso de formación médica.

Con estas tecnologías, la formación médica adquiere un grado de realidad (o, dicho de otra manera) otra forma de ser real, ofreciendo soluciones a problemas complejos con una perspectiva más allá de lo tradicional, desafiando las leyes naturales y haciendo al estudiante protagonista de esta realidad paralela, en donde experimenta, hurga, explora, escudriña, construye y deconstruye la fisiología del cuerpo humano empleando dispositivos tecnológicos de todo tipo, sin dificultad alguna dado que la mayoría pertenecen a la generación *centennials* que han pasado toda su vida en este contexto de cambio y de incertidumbre.

Ante el afán del progreso tecnológico en la educación médica, cabe preguntarse, qué tecnología reemplazará a estas tecnologías emergentes. Mientras esto suceda, las tecnologías actuales duplican la realidad lo más parecido posible o permiten insertarse en ella, concluyéndose que estas experiencias se convierten en pasado con enorme rapidez, ante las tecnologías nacientes como la inteligencia artificial, la robótica y la medicina cuántica, solo por mencionar algunas.

Referencias Bibliográficas

Arancibia Herrera, M., & Pérez San Martín, H. (2002). Antecedentes conceptuales, tecnológicos y pedagógicos para la propuesta de un modelo educativo a distancia. *Estudios pedagógicos. Valdivia, (28)*, 157-164.

Betancurth Loaiza, D. P., Vélez Álvarez, C., & Sánchez Palacio, N. (2023). La georreferenciación al servicio de la salud, una experiencia desde los activos comunitarios. *Ánfora, 30*(54). 236-253.

Cabero Almenara, J., Barroso Osuna, J., Puentes Puente, Á., & Cruz Pichardo, I. (2018). Realidad Aumentada para aumentar la formación en la enseñanza de la Medicina. *Educación Médica Superior, 32*(4), 56-69.

Castro Alonso, P. L., & Rodriguez-Florido, M. A. (2022). *La realidad virtual como recurso para la docencia en Ciencias de la Salud*. The conversation.

Cataldi, Z., Lage, F. & Dominghini, C. (2013). Fundamentos para el uso de simulaciones en la enseñanza. *Revista de Informática Educativa y Medios Audiovisuales, 10*(17), 8-16.

Dhawan, A., Kennedy, P., Rizk, E., & Ozbolat, I. (2019). Three-dimensional bioprinting for bone and cartilage restoration in orthopaedic surgery. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons, 27*(5), 215-226.

Diccionario Real Academia Española. (2003). *Diccionario de la real academia española*. Espasa-Calpe. Recuperado el 10 de septiembre de 2024, de https://dle.rae.es/cultura?m=form

Domínguez, G., Martínez, A., & Ceballos, M. (2017). Educar la virtualidad. Pixel-Bit. *Revista de Medios y Educación, (50)*, 187-199.

Fragoso, S. (2001). Espacio, ciberespacio, hiperespacio. *Razón y Palabra, (22)*. Recuperado de www.razonypalabra.org.mx

García Villegas, C., & Vidarte Pastrana, M. (2019). *Estado del arte de la bioimpresión 3D*. Colombia: Fundación M3D.

GeoLab. Web de Geometría ETSEM. (2018). *Escuela Técnica Superior de Edificación*. Universidad Politécnica de Madrid. Recuperado de www.edificacion.upm.es/geometria/JPA/Tetraedro%2001.html

Gibson, W. (2019). *Neuromancer (1984). In Crime and Media*. Routledge, 86-94.

Gutiérrez-Cirlos, C., Bermúdez-González, J. L., Carrillo-Pérez, D. L., Hidrogo-Montemayor, I., Martínez-González, A., Carrillo-Esper, R., & Sánchez-Mendiola, M. (2023). La medicina y el metaverso: aplicaciones actuales y futuro. *Gaceta médica de México, 159*(4), 286-292.

Harun, T. N., & Mantri, A. (2020). Experience Flemings rule in electromagnetism using augmented reality: analyzing impact on students' learning. *Procedia Computer Science, 172*(2020), 660-668.

Holoconnects (2023). *Next Gen Hologram Company.* Recuperado de https://www.holoconnects.com/

Kaku, M. (2011). *La física del futuro: cómo la ciencia determinará el destino de la humanidad y nuestra vida cotidiana en el siglo XXII*. Debate.

Llorens, A. (2016). *La representación gráfica del espacio tetradimensional euclídeo. La ampliación del método diédrico a cuatro dimensiones*. (Tesis Doctoral). Universidad de Sevilla, España.

Málaga G., & Sánchez, A. (2009). Medicina basada en la evidencia: Aportes a la práctica médica actual y dificultades para su implementación. *Revista Médica Herediana, 20*(2), 191-197.

Mandelbrot, B. B., Passoja, D. E., & Pullay, A. J. (1984). Nature. *Land, 308*, 721.

Microsoft.com (2023). *HoloLens 2 (2st Gen) y asistencia sanitaria*. Recuperado de https://www.microsoft.com/es-es/hololens/buy

Montes de Oca, I. (2017). Las antiguas y nuevas dimensiones de la medicina. *Revista Centro Médico, 56*(145). https://www.revistacentromedico.org/ediciones/2017/1/art-4/

Orcos, L. (2017). *Herramientas holográficas para la enseñanza de la división celular*. (Tesis de Pregrado). Universidad de la Rioja, Logroño, España. Recuperado de https://vixra.org/pdf/1704.0065v1.pdf

Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura. (1998). *El Informe Mundial sobre la Educación (1998)*. Recuperado de https://www.unesco.org/es/

Otegui, J. (2017). La realidad virtual y la realidad aumentada en el proceso del marketing. *Revista de Dirección y Administración de Empresas, 1*(24), 155-229. https://ojs.ehu.eus/index.php/rdae/article/view/19141

Ramallal, P. M., Garbellini, A. B., & Serrano, D. P. (2024). Realidad aumentada, impulso de la creatividad y las multi-inteligencias en la universidad. *Edmetic, 13*(2), 3.

Sandua, D. (2024). *El Metaverso y su impacto en las Interacciones Sociales*. Madrid: E-Book Edition David Sandua.

Vivas, D. (2012). Las tecnologías de información y comunicación como herramientas para la transformación de la salud pública. *Comunidad y Salud, 10*(2), 056-056.

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.3
Cómo citar:
Diachenko, M., Voroshchuk, O., Romanova, T., Shevtsova, N., & Tretiakova, T. (2024). Inclusive education in Ukraine: achievements, challenges, prospects. *Revista Eduweb*, *18*(4), 35-48. https://doi.org/10.46502/issn.1856-7576/2024.18.04.3

Inclusive education in Ukraine: achievements, challenges, prospects

Educación inclusiva en Ucrania: logros, retos y perspectivas

Mariia Diachenko
https://orcid.org/0000-0001-7250-1371
m.d.dyachenko@gmail.com
Doctor of Pedagogical Sciences, Professor of the Department of Education and Management of the Educational Institution, Classical Private University, Zaporizhzhia, Ukraine.
Oksana Voroshchuk
https://orcid.org/0000-0003-0835-544X
oksana.voroshchuk@pnu.edu.ua
Ph.D., in Pedagogical Sciences, Docent the Department of Social Pedagogy and Social Work, Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine.
Tetiana Romanova
https://orcid.org/0000-0002-7684-4432
romanova10tanj@gmail.com
Lecturer of the Department of Physical Therapy and Ergotherapy, Faculty of Management of Physical Culture and Sports, Zaporizhzhia Polytechnic National University, Zaporizhzhia, Ukraine.
Nataliia Shevtsova
https://orcid.org/0000-0001-9440-7597
shevtsova.ssume@gmail.com
Lecturer, Department of Theory and Practice of Romance and Germanic Languages, Department of Foreign and Slavic Philology, Sumy State Pedagogical University named after A. S. Makarenko, Sumy, Ukraine.
Tetiana Tretiakova
https://orcid.org/0000-0003-2552-5850
tatiana120516@gmail.com
Ph.D., in Political Sciences, Associate Professor of the Department of Psychology, Faculty of Psychology, Political Science, Sociologi, National University "Odessa Low Academy", Odesa, Ukraine.

Recibido: 09/07/24
Aceptado: 10/11/24

Abstract

The objective of this paper was to analyse the achievements, challenges, and prospects of inclusive education in Ukraine, focusing on the ethical principles and values that influence its implementation. The study adopted a theoretical and documentary approach, reviewing current scientific literature to explore key concepts and the ethical dimensions of inclusive education, such as justice and fairness in educational settings. The methodology involved analysing various research studies that defined the challenges of inclusion and examine the attitudes and behaviours of students and teachers towards inclusive education. Additionally, the paper evaluated existing equity assessment tools and their potential adaptation to the Ukrainian context. The most relevant findings highlight a growing global interest in inclusive education, particularly in areas like diversity, disability, early

education, and teacher training. However, ethical concerns remain a significant challenge in Ukraine, presenting opportunities for further research. The paper concludes that ethical considerations play a vital role in shaping inclusive education practices, but much work remains to be done to fully address these issues and improve equity in educational systems.

Keywords: Social integration, equal opportunities, equality, justice, values and ethical behaviour.

Resume

El objetivo de este artículo fue analizar los logros, desafíos y perspectivas de la educación inclusiva en Ucrania, centrándose en los principios éticos y valores que influyen en su implementación. El estudio adoptó un enfoque teórico y documental, revisando la literatura científica actual para explorar los conceptos clave y las dimensiones éticas de la educación inclusiva, como la justicia y la equidad en los entornos educativos. La metodología incluyó el análisis de varios estudios de investigación que definieron los desafíos de la inclusión y examinaron las actitudes y comportamientos de estudiantes y profesores hacia la educación inclusiva. Además, el artículo evaluó las herramientas de evaluación de la equidad existentes y su posible adaptación al contexto ucraniano. Los hallazgos más relevantes destacan un creciente interés global en la educación inclusiva, especialmente en áreas como la diversidad, la discapacidad, la educación temprana y la formación docente. Sin embargo, las preocupaciones éticas siguen siendo un desafío importante en Ucrania, lo que presenta oportunidades para investigaciones futuras. El artículo concluye que las consideraciones éticas juegan un papel vital en la configuración de las prácticas de educación inclusiva, pero queda mucho por hacer para abordar plenamente estos problemas y mejorar la equidad en los sistemas educativos.

Palabras clave: Inclusión social, igualdad de oportunidades, equidad, justicia, valores y comportamiento ético.

Introduction

With a variety of terminology such as 'inclusion', 'inclusive education' or 'inclusive school', contemporary discourse in education has brought inclusion to the forefront of educational debate. The concept of inclusion is confirmed at the international level, where it is of considerable interest and relevance (Acevedo & Nusbaum, 2020). Initially, attention to inclusion focused on the integration of students with disabilities or learning difficulties into the school environment. However, over time, the concept has expanded to cover broader needs. An inclusive school now ensures the educational inclusion of all children, without distinction, offers equal opportunities to all and takes into account the diversity of students. In a broader sense, an inclusive school is a micro-scale of an inclusive society, a global investment by all for all. In Europe, the structural indicators of inclusion are supported by ten key principles, which include (Table 1).

Table 1.
Key principles of inclusion in EU countries

Principle of equality and non-discrimination	**Recognises that different groups may need additional support in a respectful, nonjudgmental environment.**
The principle of listening to children's voices	Requires commitments directly related to their welfare and taking into account their age and maturity.
Building on people's assets and capabilities	Challenges the negative labels associated with vulnerable groups and goes beyond simply preventing hardship by seeking to promote everyone.
The principle of active parental involvement in school	requires a strategic focus on marginalised parents.
The principle of differentiation	Indicates that different levels of need require different prevention strategies.
The principle of multidisciplinarity	Recognises the need for a multifaceted response to complex needs.
The principle of representation of historically marginalised groups	It includes attention to processes that promote their social and professional participation.
The principle of lifelong learning	It emphasises active approaches to learning and takes into account the issues of active citizenship, personal and social realisation of intercultural dialogue, and employment.

Source: (Crane, 2020).

In this respect, inclusion should focus not only on people, but also on the systems that include them. Unfortunately, we can observe that the conversation about inclusion is often accompanied by the persistence or even increase of educational inequalities in different countries. This is due to the pedagogical difficulties faced by teachers, especially at the beginning of their careers, as well as possible resistance from families. In the context of this issue, Rix (2020) notes that in recent years, with the increasing use of private education by different social categories, schools around the world have seen a decrease in socio-cultural diversity, regardless of geographic location. This raises the question of the extent to which national governments are implementing the innovative, structural and systemic tripartite approach recommended by various European and international organisations.

The purpose of this paper is to systematise different views on the issue of inclusion by studying it in the context of Ukraine and analysing the experience of other countries. The paper aims to analyse inclusive education in Ukraine, its achievements, challenges and prospects by integrating these aspects with general educational and social challenges in modern society on the path to inclusive development. Inclusive education is often criticised for lacking a clear conceptual focus. Some researchers argue that expanding the concept to include everyone may go too far, making it problematically vague (Biju et al., 2023). We consider the opposite educational approach to this issue, arguing that expanding the scope of educational standards to include all students can be productive and efficient (educational).

To begin the Ukrainian inventory of inclusion issues, we decided to study the evolution of educational concepts in the EU. A common issue in inclusive education in all countries is the difficulty of overcoming ethical barriers. While there is general support for removing these barriers to education for all children, national policies and practices vary across regions and countries. The idea of inclusion implies that the system needs to evolve to adapt to the needs of each child, but this process rarely happens, due to limited resources, different approaches to education and differences in the interpretation of the concept of inclusion.

However, despite the fact that the literature review reveals numerous obstacles to overcoming the ethical challenges of inclusion, in the Ukrainian context inclusive education represents an achievable goal with enormous potential to strengthen social cohesion, intercultural relations and educational opportunities for all children. Therefore, the central challenge of this study is the ability of the system to mobilize all its stakeholders to support inclusion. In other words, inclusive education requires a paradigm shift at the societal level. The purpose of this paper is to analyse this transformation and offer a scientific interpretation of the educational situations studied by researchers in this field.

The objective of this paper is to analyse inclusive education in Ukraine, focusing on its achievements, challenges, and prospects, while considering the ethical principles that shape its implementation. Inclusive education in Ukraine has gained attention as part of the broader global movement towards equitable access to education, yet it faces unique challenges due to varying interpretations and limited resources. To contextualize the study, it is essential to understand that the concept of inclusion in Ukraine, as in many countries, initially centered on integrating children with disabilities into mainstream education. However, the idea of inclusive education has since expanded to embrace a broader range of students, advocating for the adaptation of the educational system to meet diverse needs.

Using a theoretical and documentary approach, this study reviews current scientific literature on inclusive education, emphasizing the ethical dimensions such as justice, fairness, and equality in educational settings. By analysing Ukraine's approach in light of broader European frameworks, such as the EU's key principles of inclusion, the paper identifies the systemic and ethical challenges that hinder the full implementation of inclusive practices. These challenges include overcoming educational inequalities, supporting teachers in implementing inclusive practices, and ensuring that inclusive education is not merely a concept but a reality for all students.

Despite the obstacles, inclusive education in Ukraine holds the potential to strengthen social cohesion, intercultural relations, and equal opportunities for all children.

Theoretical overview

Inclusive education is a deeply humanistic approach to education for all, which involves adapting the school environment to the diversity of children with special educational needs and individual learning and developmental characteristics. The main goal is to combat social exclusion and promote the active participation of individuals in all spheres of life: social, economic, cultural or political. Removing barriers in education to strengthen access, representation, participation and success of all students is one of the stated goals of inclusive education. Students with special educational needs who are included in mainstream schools develop social skills and progress towards academic inclusion. In a broad sense, inclusive education aims to improve the school setting in order to use all available resources, as reflected in the literature, including human resources and the participation of all students in the learning process (Vrăsmaș & Vrăsmaș, 2021).

International and national legislation emphasises the respect of fundamental human rights, and the principles of equality and non-discrimination must be guaranteed in all aspects of education. Equality and equity are the general principles on which efforts to achieve inclusive education are based. To promote equality in schools, it is recommended to create a positive learning environment, set clear expectations for behaviour, anti-bullying measures, a code of conduct for teachers, and address negative attitudes and discriminatory language.

To ensure that diversity is represented, children need to see their own experiences positively reflected in texts and learning resources. Equality in education is closely linked to the principle of non-discrimination. For students with special educational needs, ensuring equity in education requires "reasonable adjustments", which means making “necessary and appropriate changes and adjustments that do not impose excessive or unreasonable costs”. Learning opportunities involve a feedback system for learners where curriculum, teaching and assessment interact with each other to ensure that each learner has access to all the necessary elements to actively participate and make progress in their overall learning.

In their research, most scientists analyse forward-looking political developments and complex national realities to highlight the need for constructive critical analysis of inclusive education (Lorenzo-Lledó et al., 2024). Shume (2023) takes a particular interest in any form of discrimination that hinders inclusive pedagogy, making connections between barriers and possible actions that will promote access and participation for all. School segregation remains a significant issue worldwide, with negative consequences for children with disabilities, ethnic minorities or immigrants, and to some extent for girls. This phenomenon has many causal links that vary from country to country, according to its historical and economic context, but all of them relate to certain conceptions of otherness and structural processes of domination and discrimination.

In their article, Symeonidou & Mavrou (2020) examine the stages of development of the process of educating students with disabilities in Italian mainstream classrooms: the moment of integration, when laws were passed guaranteeing the right of every person with a disability to receive education without restrictions, the period of awareness of the need for inclusive policies that expand the concept of special educational needs and abolish the classification of students, and the phase of implementation of regulations that began in the 1990s (Bešić, 2020). According to Wang, He & Xu (2024), it is important for schools to view diversity as an opportunity that helps people interact and feel part of a community. This means that reflecting on inclusivity should become a daily norm that contributes to the development of a broader vision of an inclusive society and social change.

From a pedagogical point of view, this approach goes beyond helping certain students in the role of 'support teacher'. Therefore, it is important to separate oneself at all levels from exclusive or unilateral actions, so that each student is seen as an individual with their own needs and their learning process takes them into account. According to Pérez Valles & Reeves Huapaya (2023), it is important to broaden the vision of schools to include families by creating and supporting forms of partnership with them, and providing

assistance when they feel isolated. The authors emphasise the importance of establishing distance and tolerance in the face of difficulties faced by parents who may be anxious, inactive, intrusive, aggressive or overprotective... Inclusive education also requires partnerships with families, which should be seen as a resource in the medium term, even if the relationship may be difficult in the beginning.

In their study, Carvalho, Cosme & Veiga (2023) examine the prospects for inclusive education in Brazil, noting that the country's history is complex due to social and educational inequalities, including in the areas of economy and diverse cultural groups. Brazil's education legislation, which has been aimed at inclusion since 2008, focuses on the creation of specialised forms of support that are not intended to replace general education, but are an important element in the educational process. This approach is becoming a paradigm in the Brazilian educational environment and is aimed at providing additional support to the target audience, which includes students with disabilities, developmental disabilities and high intellectual potential.

In this context, Ukraine, like Brazil, is currently in a phase of integration that is necessary and important on the path to inclusion. The creation of “multifunctional resource rooms” is a concrete implementation of the Ministry of Education of Ukraine's commitment to meeting the unique needs of some students. According to Mansur, Utama, Mohd Yasin, Sari, Jamaludin & Pinandhita (2023), the importance of collaboration between education and science is to enable teachers to analyse their practice to address the challenges faced in the modern educational system. This collaboration involves bringing together university professors and primary and secondary school teachers. We stand in solidarity because in order to improve the process of educational inclusion of every student, we need to be able to analyse and change the way we think and organise schools to overcome the exclusion that many students face.

Dzhym, Saienko, Pozdniakova, Zhadlenko, & Kondratenko (2023) review integrative measures aimed at ensuring access to school education for students who have been the object of historical discrimination and point to the need to revise approaches to educational processes to effectively accommodate student diversity. The Ministry of Education of Ukraine has recognised this need and has taken steps to establish an extensive professional development programme. However, it is important to ensure that this programme is accessible to teachers who live far from urban centres or do not have the necessary digital equipment for distance learning. Inclusive education in Ukraine is an important area of development in the education system, which aims to create equal learning opportunities for all children, regardless of their characteristics.

Achievements in this area include the development of legislation, the creation of inclusive educational institutions, and teacher training. However, there are challenges that need to be addressed, such as the lack of public awareness of inclusive education, insufficient financial support for inclusive institutions, and a shortage of qualified inclusive education specialists. For the further development of inclusive education in Ukraine, it is necessary to focus on developing teachers' professional competencies, ensuring adequate material conditions for the education of all children, and raising public awareness of the goals and objectives of inclusive education. Thus, when entering the field of education, one should keep in mind the importance of inclusive education, its achievements and challenges to be faced, as well as the prospects for the development of this area.

Inclusive education has been a significant focus of educational reform worldwide, including in Ukraine. The country has made notable strides towards implementing inclusive education policies, aiming to provide equitable learning opportunities for all students. However, the process of inclusive education in Ukraine is still evolving, facing numerous challenges related to limited resources, professional capacity, and public awareness. Given its importance, this paper focuses on the Ukrainian context, examining the achievements, challenges, and prospects for inclusive education, while comparing these findings with countries of similar socio-political and economic contexts, such as Brazil.

Previous studies on inclusive education in Ukraine and comparable countries have employed various methodologies, ranging from qualitative interviews to quantitative surveys and literature reviews. For instance, Horishna, Polishchuk, Slozanska & Hlavatska (2020) conducted a qualitative study examining integrative measures aimed at improving school access for historically marginalized students. While their

study provides valuable insights, it faces limitations due to the small sample size and geographical concentration in urban areas. Similarly, Carvalho, Cosme & Veiga (2023) in Brazil focused on policy analysis to understand how legislative frameworks support inclusion but were limited in addressing on-the-ground implementation issues.

Martynchuk, Skrypnyk, Sofiy & Hanssen (2021) employed a mixed-methods approach, combining surveys and focus groups to examine teacher collaboration with universities. However, the study's scope was limited by its focus on a select few urban schools, excluding rural areas that may face different challenges in inclusive education. The methodologies used in these studies demonstrate both strengths and limitations in capturing the full complexity of inclusive education, particularly in rural or economically disadvantaged areas.

However, there are notable gaps in the literature on inclusive education in Ukraine. One significant gap is the lack of research on inclusive education in rural regions, where schools may face greater resource constraints and less access to professional development opportunities for teachers. Another gap lies in the limited exploration of ethical considerations in inclusive education, particularly regarding justice, fairness, and equality in educational practices. While some studies, like those of Shestakevych, Pasichnyk & Kunanets (2019), touch on the ethics of inclusion, there is insufficient analysis of how these ethical principles can be operationalized in the Ukrainian educational system.

Several studies, including those by Hordiichuk, Nikolenko, Shavel, Zakharina & Khomyk (2022), emphasize the role of ethical principles such as autonomy, justice, and fairness in the implementation of inclusive education. In Ukraine, this ethical dimension is crucial, as the country continues to reform its education system. The Ministry of Education of Ukraine has made efforts to introduce inclusive policies, yet ethical challenges remain, particularly in ensuring all students receive equal opportunities for education regardless of geographic location or socio-economic background.

Teacher training and professional development are key areas of focus in the literature. Oliinyk, Mishchenko, Ievliev, Saveliev & Hubina (2023) highlight the importance of equipping educators with the necessary skills to support inclusive education. In Ukraine, while there are professional development programs available, they are often inaccessible to teachers in rural areas or those lacking adequate digital infrastructure.

Inclusive pedagogy has been a significant topic of study, with research exploring how teaching methods can be adapted to accommodate diverse student needs. Studies such as those by Lutsan, Struk, Bulgakova, Vertuhina & Verbeshchuk (2020) suggest that inclusive pedagogical approaches should be embedded in teacher training programs. In Ukraine, however, there is still a need to integrate inclusive pedagogy into mainstream educational practices, particularly in schools that have limited experience with diverse student populations.

Comparing Ukraine with other countries, such as Brazil, reveals shared challenges in implementing inclusive education policies. Both countries face issues related to public awareness, financial constraints, and the professional capacity of educators. However, Brazil has advanced in developing legislative frameworks that support inclusion through specialised forms of support, such as multifunctional resource rooms. Ukraine has also made strides in creating resource rooms, but there remains a gap in fully operationalizing these resources across all regions.

Ethics plays a central role in the implementation of inclusive education. Ethical principles such as justice, fairness, and non-discrimination are essential to ensuring that all students have access to quality education. In Ukraine, the challenge lies in translating these ethical principles into practice, especially in regions where resources are scarce. Ethical considerations must also address the professional conduct of educators, ensuring that they are equipped to foster an inclusive environment that respects the diverse needs of all students.

The review of inclusive education in Ukraine highlights significant progress, including the development of inclusive institutions, professional development programs for teachers, and the creation of resource rooms. However, challenges remain, particularly in rural areas where access to professional training and resources is limited. Ethical considerations, such as justice and fairness, are central to the debate on inclusion and remain key challenges in Ukraine's education system. The review also identifies gaps in the current literature, particularly regarding the ethical implementation of inclusive education and the specific challenges faced in rural regions. Future research should focus on bridging these gaps and exploring the role of ethics in promoting a truly inclusive education system in Ukraine.

Methodology

The methodology of the study included an analysis of literature and documents related to inclusive education in Ukraine in recent years, which is an important step in identifying the achievements, challenges and prospects of this area of education.

The literature review conducted in this paper is based on documents extracted from the WoSCC database, Clarivate Analytics. This included high quality research and academic papers from various fields of science, social sciences and humanities. WoSCC is often used for scientific documentation as well as for bibliometric analysis in various fields. The search process was carried out in May 2024. To limit the set of documents, an advanced search was applied using the topic search (TS) option, which helped to identify the searched terms in titles, abstracts, authors' keywords, and additional keywords (Keywords plus).

The terms searched were: “inclusive education”, “inclusive learning”, “inclusive school”, “inclusive learning”, “inclusive classroom”, “inclusive university”, “inclusive academy”. To maximise search coverage, the Boolean operator OR was used to identify documents containing one, two or more search terms, as well as an asterisk (*) representing any group of characters, including no characters. For example, searching for “inclusive education*” identifies documents containing “inclusive teaching”, “inclusive teacher”, “inclusive teachers”, etc.

Identified documents (articles, conference proceedings, books, book chapters, review articles, editorials, etc.) for the period from 2019 to 2024 were included in the analysis. Those that were not relevant to the work were excluded from the analysis. The study included only scientific articles and review articles, as they are considered to be the primary sources of discoveries, research and critical analysis in the field and are subject to a rigorous peer review process provided by scientific journals to achieve certain quality standards.

WoSCC tools were used to analyse the data, in particular Analyse Results and Creation Citation Report. Thus, the frequencies of publications and citations were used to study the growth trajectory of inclusive education research over the past 31 years. To identify the main contributors, frequency tables were developed for countries, journals and authors with the largest number of publications. To study the thematic structure of research in inclusive education, the VOSviewer software tool was used, which is often used to analyse and visualise bibliometric data.

This software was used to create a bibliometric map based on the analysis of the correlation of authors' keywords, which allows visualising the main topics explored in the specialised literature. This analysis involves identifying the frequency of occurrence of certain keywords in documents written by different researchers or authors. The keywords of the documents are displayed as round nodes, the connected nodes are marked with lines and grouped into clusters of different colours. The more often keywords appear together in one publication, the higher the degree of their correlation. The formed clusters indicate the leading topics in research in the field of inclusive education.

Results and discussion

Today inclusive education is an important component of the education system in Ukraine. It involves providing learning opportunities for all children, regardless of their characteristics, needs and capabilities. The main principles of inclusive education are acceptance, participation, accessibility and quality of education for all children. A number of key issues can usually be identified in the documents and literature studied in the course of the analysis. These include the state of the infrastructure for inclusive education, teacher training, curricula and methods of working with students with special needs, support for families and students in need of inclusive education, and the introduction of changes to education legislation.

Achievements in the field of inclusive education in Ukraine include an increase in the number of institutions providing inclusive education, improved learning environments for children with special needs, the development of inclusive curricula and work with teachers working with such students. However, inclusive education in Ukraine faces a number of challenges, including the ethical aspect, which is highlighted in this paper and has not been studied much. The prospects for inclusive education in Ukraine lie in the further development of programmes and teaching methods for all students, professional development of teachers in the field of inclusive education, and the harmonisation of legislation with international standards in this area. Thus, the analysis of literature and documents on inclusive education in Ukraine allows us to reveal the current state, achievements, challenges and prospects of this field, which will become the basis for further improvement of the education system for the benefit of all students.

Research shows that educational discrimination continues to exist in Ukraine, leading to inequality in access to quality education for different social groups (Chaika et al., 2024; Carrington & Kimber, 2020). This jeopardises the very existence of political and social equality in the country. Research findings suggest that additional measures are needed to address this problem and ensure equal opportunities for all Ukrainian citizens. In this context, Dubiaha & Shevchenko (2022) point to the need to develop (non-artificial) intercultural contacts in education. They model these encounters as follows: those based on coexistence and interpersonal similarities that insist on a common belonging to humanity; those animated by the creation of joint projects aimed at transcending the distinctive and defensive identity of each group; those based on the possibility of confronting existing points of view, in particular the minority point of view; and finally, those focused on storytelling, through which the telling and mutual exchange of experiences and suffering allowed for the development of empathy.

The Ministry of Health supports learning opportunities in inclusive education contexts through the ethical principles of equity for all persons (Order No. 585-2003-p, 2003). It is believed that without equal learning opportunities, students with special educational needs may experience lower social and academic achievement. They may not realise their full potential, which puts them at a disadvantage both in childhood and in adulthood. Shevchuk, Mokhonchuk, Lysodyed & Mamonova (2020) emphasise that additional elements are needed to create real learning opportunities for students with special educational needs, such as (Figure 1).

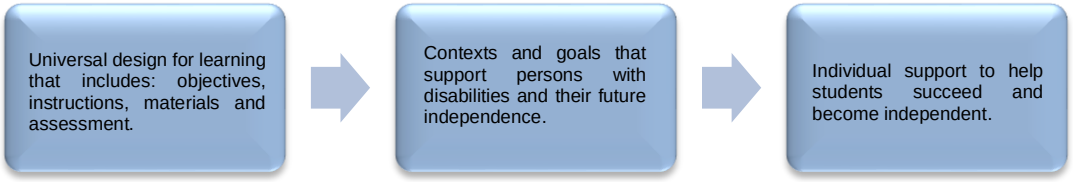

Figure 1. Additional elements for creating conditions for students with special needs.
Source: Sasse (2020).

The introduction of new terminology such as 'additional support needs', which in some countries has replaced the term 'special educational needs', was primarily about destigmatisation (Ioannidi & Malafantis, 2023). Thus, all children and adolescents, including those in Ukraine, can request additional support at a certain stage of their education, and local authorities have a duty to provide this additional support when necessary. In summary, the Ukrainian education system is gradually shifting from 'special needs' to the concept of 'learning for all'.

Support for children with educational needs also requires effective collaboration with their parents. Strong communities of students, teachers and parents foster the consensus and commitment needed to realise the universal values of inclusion and equity (Wang, He & Xu, 2024; Hodkinson, 2020). A very acute challenge is the issue of ethics and equity in inclusive education. Equity in education is the subject of a significant number of international documents and projects. Semigina & Chystiakova (2020) define equity in education as “the right to an equitable and inclusive education system that provides high quality education and opportunities for personalised learning, personal and social development”. This highlights six dimensions of equity in education (Table 2).

Table 2.
Equity dimensions in education

Dimensions	Examples
Access	Equity in education means ensuring that all students have equal opportunities to access high-quality education, regardless of their background, location, or socioeconomic status.
Resources	Equity in education involves providing each student with the resources they need to succeed, such as well-trained teachers, up-to-date instructional materials, and support services.
Support	Equity in education requires providing students with the support they need to overcome barriers to learning, such as language barriers, disabilities, or trauma.
Diversity and Inclusion	Equity in education means valuing diversity and promoting inclusion in the classroom, ensuring that all students feel welcome, respected, and represented.
Achievement	Equity in education involves closing achievement gaps between different student groups and ensuring that all students have the opportunity to excel academically.
Opportunities	Equity in education means providing all students with the same opportunities to participate in extracurricular activities, advanced placement courses, and other enriching experiences.
Accountability	Equity in education requires holding schools, districts, and policymakers accountable for addressing inequities and ensuring that all students have access to a high-quality education.

Source: Authors’ own development.

Depending on the project objectives, each of the above dimensions is linked to a specific perspective: systemic, meaning how the school understands and implements systemic norms, system regulation, how the school is organised and managed to achieve these dimensions, or individual, meaning that the school's actions are focused on student learning.

Arguments for and against inclusive education from different ethical theories

Ethical theories define different approaches and analyses of educational practices. Utilitarian theory focuses on the outcomes or consequences of our actions, analysing the relationship between the moral value of an action and its consequences. From a utilitarian perspective, changes in education seem to be driven by utilitarian calculations. Utilitarians in education weigh the costs and benefits of individual education, such as care, protection and realistic expectations, against the overall peace of education and conclude that the weight of the good falls on a system of relative withdrawal that provides the appropriate environment with the educational capacity to protect a child with educational needs from the harsh conditions of school life.

Another argument of utilitarians who support the separation of children with special educational needs is the teacher's time in the regular classroom. Children with educational needs require more effort and longer time from the teacher, who may take a hostile stance to inclusion (Suri, 2020). In contrast to utilitarian theory, deontological theory focuses on the extent to which good and evil are inherent properties of a moral act in itself, regardless of how that act evolves (Shestakevych, Pasichnyk, & Kunanets, 2019). Deontologists believe that it is morally wrong to harm an innocent person even if this action leads to saving the lives of any other persons, i.e. to use a person as a means to an end, a conclusion that is not supported by utilitarians (Kozibroda, Kruhlyk, Zhuravlova & Chupakhina, 2020; Olena et al., 2022). Deontologists argue that by embracing inclusion, they are fulfilling their moral obligation to the national economy, the educational system, or persons with disabilities (Table 3).

Table 3.
Equity dimensions in education

Advantages	Disadvantages
Encouraging inclusion in all areas of society allows every individual to feel valuable and important.	Some individuals may feel insecure or uncomfortable in situations where they interact with others with different needs or abilities.
Supporting inclusive culture enhances trust and cooperation among people from different social and cultural groups.	Implementing inclusion on a large scale may require significant financial, time, and organizational efforts for businesses and institutions.
Providing equal opportunities for all leads to the creation of a more just society.	It may not always be possible to achieve full inclusion in all areas of life as inclusive measures may encounter stereotypes and social limitations.

Source: Authors' own development.

Integrity ethics highlights the character of decision makers. The most important task from the perspective of virtue ethics is to consider character traits, virtuous qualities that lead a person to morally right actions. Analysing inclusive education from the perspective of virtue ethics, Horishna, Polishchuk, Slozanska, & Hlavatska (2020) believe that this is the most appropriate approach to building a general ethics of inclusive education. Patience, organisation, creativity, acceptance, intuition and calm resilience are considered essential virtues for teachers in inclusive education. These are complemented by courage, kindness, honesty, perseverance, compassion, integrity, humour, enthusiasm, optimism and wisdom.

Care ethics is another ethical theory that is being incorporated into inclusive education. Yıkmış (2022) defines care as "a set of relational patterns that promote mutual recognition and achievement, growth, development, protection, enhancement, and social, cultural, and empowerment". According to Anderson (2020), a classroom based on an ethic of care should include the following characteristics (Table 4).

Table 4.
Characteristics of care ethics

Condolences	Creating an environment where all students feel welcome and accepted.
Friendliness	Providing each student with what they need to learn effectively.
Presence	Mental and emotional accessibility of teachers to their students, self-assessment of design and correct assessment of students' strengths and weaknesses.
Interdependence between classmates	Recognition of the mutuality of responsibilities and connections between all class members.
Relationships	Starting with recognising the dignity of every student, including those with severe or profound disabilities, and acknowledging situations where a student without a disability may be placed in a group with a student with a disability, the latter being able to assist their non-disabled friend at certain points.
Authenticity	The teacher's willingness to acknowledge and accept responsibility for mistakes and openness to trying something new.

Source: Authors' own development.

Barriers and ethical aspects of inclusive education

There are many studies that analyse the barriers to inclusive education. Hornby & Kauffman, (2024) identify the following categories of barriers: barriers that manifest themselves in the school context and in perceptions; resource-related barriers; barriers that manifest themselves in the response of the educational process; barriers related to gender, age and level of training (Anderson, 2020).

We assess that from an ethical perspective, principles such as the achievement of inclusion, equality and justice, cooperation, compassion, beneficence, dignity and trust between parties are at risk. The category of barriers related to resources includes situations where facilities and services in educational centres are not accessible to students with disabilities, some educational institutions do not have adequate resources and support for students with disabilities, information is not provided in different ways for students with functional diversity, and technology is not used to meet the needs of students.

According to Kovalyshyn, Vivcharenko & Gryshko (2020), inadequate working conditions for support teachers, including the lack of special rooms for interventions and therapy in secondary schools, as well as insufficient material support, such as lack of ramps, accessible furniture and toilets, or low financial status of families, make it difficult to access the necessary resources. These aspects create significant barriers and violate ethical principles such as equity, accessibility, well-being, presence, interdependence and cooperation among classmates.

The response of the Ukrainian educational system does not always meet appropriate standards due to the use of undifferentiated and low-productive teaching methodologies, low levels of student motivation to learn, and the lack of organisational or curricular strategies that promote interest in diversity. Insufficient cooperation of teachers working in inclusive education with colleagues in the school and other educational institutions calls into question the ethical principles of autonomy and independence (Sarancha et al., 2022).

The absence of learning opportunities for children with or without special educational needs points to ethical aspects related to their acceptance of difference or compassion for their contribution to the social fabric of an ethical society (Hrabovets et al., 2020; Pokharel et al., 2024). Mu (2021) notes the existing dilemma between the principle of equality that applies to all students in the classroom and the provision of individualised support for students with special needs, and questions the extent to which educators' support for students with special needs helps them learn something about their contribution to the social fabric of an ethical society, and whether colleagues without special needs learn anything about inclusion and acceptance.

Other ethical aspects of inclusive education are noted as creating hierarchical barriers, but the main problem here is the lack of educational resources, increased training efforts for multi-level learning activities, classroom management issues and the low quality of educational activities in inclusive settings for students with special educational needs (Pokharel et al., 2024).

Based on the proposed general equity analysis framework for the evaluation and self-evaluation of teachers working in inclusive education, Bulakh (2020) identifies that most of its sub-sections can be integrated and adapted in the Ukrainian education system. This selection includes equity analysis criteria such as the right to education and participation, consideration of the individual needs of students with special educational needs in inclusive education, gifted students, new students, and aspects related to gender, ethnicity, and interculturality, in line with international standards of inclusion.

Conclusions

The study identifies several key ethical principles and challenges in implementing inclusive education in Ukraine. Among these, the most prominent are the principles of equality, non-discrimination, justice, and the creation of equitable learning opportunities. The research demonstrates that inclusive education is supported by positive values such as a sense of belonging, acceptance, meaningful student participation,

visible learning outcomes, and positive attitudes from key stakeholders—teachers, students, parents, and school management. Additionally, the study highlights the importance of collaboration, compassion, dignity, and mutual trust as vital for fostering an inclusive educational environment. Conversely, barriers to inclusion include a lack of professional capacity, inadequate material resources, and a limited understanding of inclusion principles by some teachers and stakeholders.

Ukraine has made considerable progress in establishing inclusive educational frameworks, evidenced by the development of inclusive institutions, professional development programs for teachers, and legislative initiatives. Resource rooms and professional development opportunities have been introduced to help address the specific needs of students with disabilities.

The study highlights several ongoing challenges, particularly the lack of public awareness about inclusive education, insufficient funding, and the uneven distribution of resources, particularly in rural areas. Teacher training and professional development are often inaccessible to educators in remote regions, leading to inconsistent application of inclusive practices across the country.

The future of inclusive education in Ukraine holds great potential. Further development depends on enhancing public understanding, securing financial support, and expanding teacher training programs to reach all regions. Moreover, the ethical dimensions of inclusion—such as fairness, justice, and equity—must be embedded into all aspects of the educational system to ensure the long-term success of inclusive practices.

In conclusion, the study provides a comprehensive analysis of the ethical principles, values, and barriers affecting inclusive education in Ukraine, offering a framework for future research and practice. Addressing these ethical challenges will be crucial for strengthening inclusive education and ensuring equal opportunities for all students.

Referencias Bibliográficas

Acevedo, S. M., & Nusbaum, E. A. (2020). Autism, neurodiversity, and inclusive education. In *Oxford Research Encyclopedia of Education*. Oxford. https://doi.org/10.1093/acrefore/9780190264093.013.1260

Anderson, D. W. (2020). The ethic of care and inclusive education. Smith, D.I. (editor) *How Shall We Then Care*, 112-124. Wipf & Stock. https://acortar.link/Mt2U2d

Bešić, E. (2020). Intersectionality: A pathway towards inclusive education? *Prospects*, *49*(3-4), 111-122. https://link.springer.com/article/10.1007/s11125-020-09461-6

Biju, S., Pallath, V., More, B., Valsaraj, B. P., & Ng, K. H. (2023). Future inclusive education. In *Improving Inclusivity in Higher Education: Addressing the Digital Divide in the COVID Pandemic* (pp. 203-216). Singapore: Springer Nature Singapore. https://link.springer.com/chapter/10.1007/978-981-99-5076-8_13

Bulakh, T. (2020). Entangled in social safety nets: Administrative responses to and lived experiences of internally displaced persons in Ukraine. *Europe-Asia Studies*, *72*(3), 455-480. https://doi.org/10.1080/09668136.2019.1687648

Carrington, S., & Kimber, M. (2020). Ethical leadership for inclusive schools. *Australian Educational Leader*, *42*(2), 10-14. https://search.informit.org/doi/abs/10.3316/INFORMIT.438806491757062

Carvalho, A. E., Cosme, A., & Veiga, A. (2023). Inclusive education systems: The struggle for equity and the promotion of autonomy in Portugal. *Education Sciences*, *13*(9), 875. https://doi.org/10.3390/educsci13090875

Chaika, O., Sharmanova, N., & Makaruk, O. (2024). Revitalising endangered languages: Challenges, successes, and cultural implications. *Future of Social Sciences, 2*(2), 38-61. https://doi.org/10.57125/FS.2024.06.20.03

Crane, A. (2020). The politics of development and humanitarianism in EU externalisation: Managing migration in Ukraine. *Environment and Planning C: Politics and Space*, *38*(1), 20-39. https://doi.org/10.1177/2399654419856908

Dubiaha, S., & Shevchenko, Y. (2022). The impact of inclusive practices on academic performance in primary school. *AD ALTA: Journal of Interdisciplinary Research*, *12*(2), 124-127. http://eprints.mdpu.org.ua/id/eprint/12714/1/124-127.pdf

Dzhym, V., Saienko, V., Pozdniakova, O., Zhadlenko, I., & Kondratenko, V. (2023). Intensification of sport activities in the process of training higher education seekers of various specialities. *Revista Eduweb, 17*(2), 43-53. https://doi.org/10.46502/issn.1856-7576/2023.17.02.4

Herasymenko, O., Hrytsai, N., Karskanova, S., Pliushch, V., & Protsenko, I. (2024). Development of research competence in university students through cloud-oriented technologies: a pedagogical experiment. *Amazonia Investiga*, *13*(77), 66–80. https://doi.org/10.34069/AI/2024.77.05.5

Hodkinson, A. (2020). Special educational needs and inclusion, moving forward but standing still? A critical reframing of some key issues. *British Journal of Special Education*, *47*(3), 308-328. https://doi.org/10.1111/1467-8578.12312

Hordiichuk, O., Nikolenko, L., Shavel, K., Zakharina, M., & Khomyk, T. (2022). Analysis of models of inclusive education in European countries (experience for Ukraine). *Revista Eduweb*, *16*(4), 32-41. https://www.revistaeduweb.org/index.php/eduweb/article/view/476

Horishna, N., Polishchuk, V., Slozanska, H., & Hlavatska, O. (2020). Trends in the development of inclusive education in Ukraine. *Educational Dimension*, *3*, 103-116. https://acnsci.org/journal/index.php/ed/article/view/477

Hornby, G., & Kauffman, J. M. (2024). Inclusive education, intellectual disabilities and the demise of full inclusion. *Journal of Intelligence*, *12*(2), 20. https://doi.org/10.3390/jintelligence12020020

Hrabovets, I., Kalashnikova, L., & Chernous, L. (2020). The problems of implementation of inclusive education in Ukraine: generalisation of the experience of empirical sociological research experience. In *SHS Web of Conferences* (Vol. 75, p. 03011). EDP Sciences. https://doi.org/10.1051/shsconf/20207503011

Ioannidi, V., & Malafantis, K. D. (2023). Inclusive education and creative learning styles. International opportunities and challenges. *European Journal of Literature, Language and Linguistics Studies*, *7*(1). https://oapub.org/lit/index.php/EJLLL/article/view/445

Kovalyshyn, O. R., Vivcharenko, O. A., & Gryshko, U. P. (2020). Legal borrowings in the area of civil rights and interests protection under the legislation of Ukraine and the EU. *Journal of Sustainability Studies*, (2020/1). https://doi.org/10.3280/RISS2020-001018

Kozibroda, L. V., Kruhlyk, O. P., Zhuravlova, L. S., & Chupakhina, S. V. (2020). Practice and innovations of inclusive education at school. *International Journal of Higher Education*, *9*(7), 176-186. https://eric.ed.gov/?id=EJ1277512

Lemeshchuk, M., Pisnyak, V., Berezan, V., Stokolos-Voronchuk, O., & Yurystovska, N. (2022). European practices of inclusive education (experience for Ukraine). *Amazonia Investiga*, *11*(55), 80–88. https://doi.org/10.34069/AI/2022.55.07.8

Lorenzo-Lledó, A., Lorenzo Lledó, G., Lledó, A., & Pérez-Vázquez, E. (2024). Inclusive education at university: A scientific mapping analysis. *Quality & Quantity*, *58*(2), 1603-1627. https://link.springer.com/article/10.1007/s11135-023-01712-w

Lutsan, N. I., Struk, A. V., Bulgakova, O. Y., Vertuhina, V. M., & Verbeshchuk, S. V. (2020). The transformative changes of inclusive education in Ukraine. *Journal of Advanced Pharmacy Education & Research*, (*10* (4)), 169-173.

Mansur, H., Utama, A. H., Mohd Yasin, M. H., Sari, N. P., Jamaludin, K. A., & Pinandhita, F. (2023). Development of inclusive education learning design in the era of society 5.0. *Social Sciences*, *12*(1), 35. https://doi.org/10.3390/socsci12010035

Martynchuk, O. V., Skrypnyk, T. V., Sofiy, N. Z., & Hanssen, N. B. (2021). Inclusive education in Ukraine: Tension between policy and practice. In *Dialogues between Northern and Eastern Europe on the Development of Inclusion* (pp. 148-167). Routledge. https://acortar.link/5XlCtx

Mu, G. M. (2021). Time to ring the death knell for agency and resilience? Some sociological rethinkings of inclusive education. *International Journal of Disability, Development and Education*, *68*(6), 822-830. https://doi.org/10.1080/1034912X.2020.1866751

Olena, P., Dariia, P., Hrechanyk, N., Kateryna, Y., & Serhii, N. (2022). ICT-oriented training of future HEI teachers: A forecast of educational trends 2022-2024. *International Journal of Computer Science & Network Security*, *22*(4), 387-393. https://doi.org/10.22937/IJCSNS.2022.22.4.45

Oliinyk, T., Mishchenko, O., Iievliev, O., Saveliev, D., & Hubina, S. (2023). Inclusive education in Ukraine: conditions of implementation and challenges. *Cadernos de Educação Tecnologia e Sociedade*, *16*(se2), 50-62. http://www.brajets.com/index.php/brajets/article/view/1286

Order No. 585-2003-p. On the establishment of the duration of obtaining a complete general secondary education by persons with special educational needs in institutions of general secondary education. *Cabinet of Ministers of Ukraine*, April 23, 2003. https://zakon.rada.gov.ua/go/585-2003-п

Pérez Valles, C., & Reeves Huapaya, E. (2023). Educación inclusiva digital: Una revisión bibliográfica actualizada. Las brechas digitales en la educación inclusiva. *Actualidades Investigativas en Educación*, *23*(3), 3-28. http://dx.doi.org/10.15517/aie.v23i3.54680

Pokharel, S., Pandey, A., & Dahal, S. R. (2024). Globalization, brain drain, and its impact in Nepal. *Future Philosophy, 3*(3), 4-21. https://doi.org/10.57125/FP.2024.09.30.01

Rix, J. (2020). Our need for certainty in an uncertain world: the difference between special education and inclusion? *British Journal of Special Education*, *47*(3), 283-307. https://doi.org/10.1111/1467-8578.12326

Sarancha, I., Kovinko, M., Maksymchuk, B., Tarasenko, H., Kharchenko, S., Demchenko, I., Dovbnia, S., Rudenko, L., Symkanych, O., Martyniuk, T., Bilan, V., & Maksymchuk, I. (2022). Horticultural Therapy Course as an Educational-Therapeutic Tool of Rehabilitation for Individuals with MSDs. *Romanian Magazine for Multidimensional Education, 14*(3), 180-200. https://doi.org/10.18662/rrem/14.3/604

Sasse, G. (2020). War and displacement: the case of Ukraine. *Europe-Asia Studies*, *72*(3), 347-353. https://doi.org/10.1080/09668136.2020.1728087

Semigina, T., & Chystiakova, A. (2020). Children with down syndrome in Ukraine: inclusiveness beyond the schools. *The New Educational Review, 59*, 116-126. DOI: 10.15804/tner.2020.59.1.09

Shestakevych, T., Pasichnyk, V., & Kunanets, N. (2019). Information and technology support of inclusive education in Ukraine. In *Advances in Computer Science for Engineering and Education, vol. 13* (pp. 746-758). Springer International Publishing. https://doi.org/10.1007/978-3-319-91008-6_73

Shevchuk, O. M., Mokhonchuk, S. M., Lysodyed, O. V., & Mamonova, V. V. (2020). On some features of the implementation of the right to inclusive education of people with disabilities in Ukraine. *Humanities and Social Sciences Reviews*, *8*(S2), 102-108. https://doi.org/10.18510/hssr.2020.82e11

Shume, T. J. (2023). Conceptualising disability: a critical discourse analysis of a teacher education textbook. *International Journal of Inclusive Education*, *27*(3), 257-272. https://doi.org/10.1080/13603116.2020.1839796

Suri, H. (2020). Ethical Considerations of Conducting Systematic Reviews in Educational Research. In: Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., Buntins, K. (eds) *Systematic Reviews in Educational Research*. Wiesbaden: Springer. https://link.springer.com/chapter/10.1007/978-3-658-27602-7_3

Symeonidou, S., & Mavrou, K. (2020). Problematising disabling discourses on the assessment and placement of learners with disabilities: can interdependence inform an alternative narrative for inclusion? *European Journal of Special Needs Education*, *35*(1), 70-84. https://doi.org/10.1080/08856257.2019.1607661

Vrăsmaș, T., & Vrăsmaș, E. (2021). *On the Road to Inclusive Education in Romania: Contribution of the RENINCO Networks.* University Publishing House. https://doi.org/10.5682/9786062813697

Wang, C., He, Q., & Xu, J. (2024). Exploring the role of quality and inclusive education in meeting sustainable development goals. *Economic Change and Restructuring*, *57*(3), 1-15. https://link.springer.com/article/10.1007/s10644-024-09690-1

Yıkmış, G. (2022). Opinions and suggestions of preservice special education teachers on ethical principles. *Cypriot Journal of Educational Sciences*, *17*(4), 1385-1398. https://www.ceeol.com/search/article-detail?id=1048811

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.4
Cómo citar:
Tovkanets, O., Popova, L., Ivanytska, N., Kmit, O., & Paska, T. (2024). Innovative technologies in the development of teachers' professional competence. *Revista Eduweb*, *18*(4), 49-67. https://doi.org/10.46502/issn.1856-7576/2024.18.04.4

Innovative technologies in the development of teachers' professional competence

Tecnologías innovadoras en el desarrollo de la competencia profesional de los profesores

Oksana Tovkanets
https://orcid.org/0000-0003-4438-0167
oksana.tovkanets@uzhnu.edu.ua
WoS Researcher ID: AAZ-4079-2021
Doctor of Sciences (Pedagogy), Professor, Professor of the General Pedagogy and Pedagogy of the Higher School Department, State Higher Educational Institution «Uzhhorod National University», Ukraine.

Liudmyla Popova
https://orcid.org/0000-0003-3764-3870
liudmyla.plm@gmail.com
WoS Researcher ID: LFV-1780-2024
Candidate of Pedagogical Sciences, Associate Professor, Department of Theory, Practice and Translation of the English Language, National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute", Ukraine.

Nataliia Ivanytska
https://orcid.org/0000-0002-1422-1176
nataliaivanucka.01@gmail.com
WoS Researcher ID: KBA-4261-2024
Ph.D. Doctoral Student, Institute of Pedagogical Education and Adult Education named after Ivan Zyazyun of the National Academy of Sciences of Ukraine, Ukraine.

Olena Kmit
https://orcid.org/0000-0003-3396-7798
elenakmit64@gmail.com
WoS Researcher ID: HZI-4276-2023
Candidate of Pedagogical Sciences, Associate Professor, Associate Professor of Languages and Their Teaching Methodology Department, T. H. Shevchenko National University «Chernihiv Colehium», Ukraine.

Taras Paska
https://orcid.org/0000-0002-4579-388X
taras.paska@pnu.edu.ua
WoS Researcher ID: GRY-1072-2022
Doctor of Philosophy (PhD in Pedagogy), Assistant of the Bohdan Stuparyk Department of Pedagogy and Educational Management, Vasyl Stefanyk Precarpathian National University, Ukraine.

Recibido: 10/10/24
Aceptado: 23/12/24

Abstract

The article analyzes the content of the main concepts of the study and highlights the key types of innovative technologies. It demonstrates the pathways in the process of professional training for modern teachers,

which will allow for the formation of practical experience, the knowledge component necessary for further work in the professional field, and the development of an innovative and effective system for preparing future educators. The main innovative educational technologies necessary for the formation of professional competence in teachers are identified. The role of digitalization in education in shaping teachers' professional competence is clarified; the advantages of using immersive technologies in developing teachers' professional competence are shown. The research-experimental work to study the effectiveness of the formation of professional competence in future teachers through the use of innovative technologies, based on defined pedagogical conditions, was conducted in the following interrelated stages: preparatory stage, diagnostic stage, and formative stage. Students, university lecturers, and school teachers participated in the research-experimental work. The results of the comparative analysis between the diagnostic stage and the formative stage of the experiment demonstrated significant changes in all components of professional competence.

Keywords: professional competence, professional interaction of teachers, students, lecturers, innovative technologies, immersive technologies.

Resumen

El artículo analiza el contenido de los principales conceptos de investigación y destaca los principales tipos de tecnologías innovadoras. Se muestran las formas en que, en el proceso de formación profesional de un docente moderno, brindará la oportunidad de formar experiencia práctica, un componente de conocimiento para el trabajo posterior en el campo profesional y desarrollar un sistema innovador y eficaz de formación de futuros docentes. Se destacan las principales tecnologías educativas innovadoras necesarias para la formación de la competencia profesional de los docentes. Se aclara el papel de la digitalización de la educación en la formación de la competencia profesional de los docentes; Se muestran las ventajas del uso de tecnologías inmersivas en la formación de la competencia profesional de los docentes. Se llevaron a cabo investigaciones y trabajos experimentales sobre la eficacia de la formación de la competencia profesional de los futuros docentes utilizando tecnologías innovadoras basadas en condiciones pedagógicas definidas en las siguientes etapas interconectadas: etapa preparatoria; etapa de verificación; etapa formativa. En los trabajos de investigación y experimentación participaron estudiantes, profesores de instituciones de educación superior y profesores de escuela. Los resultados del análisis comparativo de la etapa de determinación del experimento y la etapa de formación del experimento demostraron que hay cambios significativos en todos los componentes de la competencia profesional.

Palabras clave: competencia profesional, interacción profesional de profesores, estudiantes, profesores, tecnologías innovadoras, tecnologías inmersivas.

Introduction

In the modern global space, the information acquired by individuals is changing at a dizzying pace. Therefore, in the current educational process, it is important to open new horizons through innovative activities, striving to explore unknown information rather than merely accumulating knowledge. There is a growing demand for teachers who are both advisors and inspirers, capable of implementing innovative technologies and breaking away from outdated educational templates. To meet these new demands, teachers must use and consider modern innovative technologies in accordance with widely accepted principles of teaching. Only a creative and flexible mind will enable teachers to quickly achieve results in their professional activities and adapt to the rapid changes constantly occurring in the world. One of the most important tasks in the professional training of future teachers, which pedagogical education faces today, is the application and search for innovative technologies aimed at enhancing the level of professional-pedagogical training of specialists and forming the professional competence of future teachers (Balukh, 2024).

At the current stage of socio-cultural and socio-economic transformations in society, new priorities are driving radical changes through digital technologies and the mastery of Internet resources. This shapes the ability to operate basic settings and provides experience in using new technologies for future professions, particularly in the use of ICT (Information and Communication Technologies) for working with professional materials (Filonenko, 2024).

The goal of forming teachers' professional competence through innovative technologies is to develop a creative and active personality in future professionals, capable of independently using digital technologies to adjust and structure their educational and cognitive activities.

In the global educational space, there has been a shift from traditional learning to hybrid and online learning. Educational institutions, instructors, and teachers in the new conditions of innovative learning are experimenting with novel strategies to engage learners at all levels and enhance their professional orientation through innovative technologies. The digital programs developed by specialists aim to provide students with the best access to classes.

For example, in 2021:

- 57% of all U.S. students had their own digital tools;
- 75% of U.S. educational institutions fully planned to transition to virtual mode;
- 40% of students' device usage was dedicated to educational platforms;
- The use of remote management apps for educational purposes increased by 87%;
- The use of collaboration apps increased by 141%;
- 80% of U.S. universities and schools purchased additional technological tools for learners;
- 98% of universities were teaching online until the end of 2020 (Tran, 2024).

Thus, the presented data highlight the changes in teaching and learning in modern society. Therefore, the main challenge today is the innovative training of specialists who can think creatively – professionals of a new caliber, capable of making unconventional decisions, quickly navigating the modern information space, and continuously developing and learning throughout their lives (Marusynets et al., 2022). The primary tasks of innovative and scientific activities in higher education institutions are to ensure the innovative development of society, acquire knowledge through scientific research and development, direct these achievements toward the implementation and creation of new competitive technologies, and prepare innovative professionals, particularly teachers, who are key to the development of humanity's intellectual potential (Tanska et al., 2024). Therefore, the issue of forming teachers' professional competence through innovative technologies is crucial and necessary in the present day.

Literature Review

To explore the practice of using innovative technologies in the educational process of higher education, we conducted an analysis of scientific research on the formation of future teachers' professional competence through innovative technologies.

O. Komar (2024) reveals the peculiarities of forming digital competence in future primary school teachers for the application of information and digital technologies in mathematics lessons in the context of higher education institutions. It was found that the digital competence of a future specialist, considering the existing opportunities and limitations, involves the ability to independently, responsibly, and purposefully use information and digital technologies in their professional activities. Stages were developed for forming future primary school teachers' readiness to use information and digital technologies in mathematics lessons, with one of the most effective methods being the familiarization of students with educational software tools that are mandatory in primary schools and improving the digital competence of future primary school teachers. The study takes into account organizational, pedagogical, psychological, and methodological factors.

In the formation of professional linguo-cultural competence in future specialists, O. Filonenko (2024) highlights the peculiarities of using information and communication technologies. It was found that in the process of using information and communication technologies, by improving and mastering professional communicative competence, students undergo linguo-cultural integration into the structure of interaction and relationships, within the context of which the individual acquires connections (functional-communicative), which are regulated based on information-technology capabilities, modern methods, forms, and correspond to the demands of linguistic reality and contemporary culture.

M. Balukh (2024), based on the systematization of the experience of training future teachers, proposed innovative health-saving technologies that are effective when used in the educational process of higher education institutions. These include "Runkeeper", "Endomondo", "Nike+GPS", "Adidas miCoach", "My Tracks", "Workout Trainer", "Sports Tracker", "Coaches Eye", "TGFU Games". He demonstrated the significance of applying innovative health-saving technologies in the higher education process, which help develop the professional competence of future specialists, foster positive motivation for self-development, and expand the range of pedagogical skills, knowledge, and interests of future teachers.

A. Kostyk & M. Oliynyk (2024) examined the use of innovative technologies in the professional activities of speech therapists. It has been proven that the purpose of such technologies is to improve corrective and developmental work with children. In overcoming speech disorders in preschool children, these technologies contribute to achieving the maximum possible success, alongside traditional technologies (fairy tale therapy (through the dramatization of fairy tales, role-playing – correction), art therapy (treatment through creativity), aesthetic therapy (impact on personal development through visual arts), pine cone therapy, acorn therapy, sand therapy (tactile impact on the sensory receptors of sand), music therapy (influence through music perception), kinesitherapy (rhythmic – phonetic and speech therapy), etc.).

Zh. Kartashova & M. Kuziv (2024) dedicated their research to the study of innovative approaches, methods, and technologies for teaching music theory disciplines aimed at forming the professional competencies of future music teachers. They analyzed innovative technologies, techniques, and methods used in higher education for training future music teachers. The researchers defined the essence of the concept of "professional competence of the future music teacher" and identified the structural components of professional competence, each characterized by specific indicators: cognitive (ethnocultural and content indicators), personal (indicator of personally significant qualities and communicative indicator), goal-motivational (value-motivational indicator), activity-based (indicator of flexibility in responding to educational changes and creative-activity indicator), and reflexive-forecasting (evaluative-generalizing) indicator.

The research activities of M. Malakhova & O. Ovcharenko-Pieshkova (2024) are also dedicated to this problem, specifically addressing the preparation of future music teachers using innovative technologies to develop students' artistic and creative competencies as a component of cultural competence. It has been proven that the effectiveness of forming the artistic and creative competence of primary school students depends on the level of skills, abilities, and artistic-creative knowledge acquired by future music teachers through innovative educational technologies and their ability to implement these in their professional-pedagogical activities. The researchers conducted a theoretical analysis of the concepts of "artistic and creative competence of students," "preparation of the music teacher," and "teacher training" based on their findings. It was clarified that the artistic and creative competence of a student is a dynamic personal formation based on artistic-creative knowledge, an artistic-aesthetic worldview, and the abilities and capacities of individuals to engage in artistic-creative activities in primary school with a practically valuable attitude. It has been substantiated that the application of health-saving technologies in music lessons – such as music therapy, fairy tale therapy, dance-movement therapy, vocal therapy, etc. – exerts a dual influence on students. These technologies ensure the preservation of personal health, impact the development of artistic-creative abilities, and contribute to the formation of artistic and creative competence. The importance of using time management technologies for effective time organization and the development of independence among future music teachers has been demonstrated, emphasizing their

ability to implement leading methods through innovative technologies in the process of forming students' artistic and creative competencies.

Our analysis of scientific research on the problem of forming the professional competence of future teachers through innovative technologies indicates that the possibilities for improving the training of future teachers are limitless and are rooted in the use of innovative technologies. There is a significant interest among researchers in: revealing the features of forming digital competence in future teachers, developing artistic and creative competence; uncovering ways to apply information and digital technologies in higher education institutions; highlighting the specifics of using information and communication technologies and health-saving innovative technologies, which are effective when used in the educational process of higher education; and exploring innovative approaches, methods, and teaching technologies during the study of professional disciplines to form the professional competencies of future teachers. The analysis of scientific research on the identified problem demonstrates insufficient attention to the practice of using innovative technologies in the higher education process.

Research Aim: to demonstrate the importance and methods of forming the professional competence of teachers through innovative technologies.

Methodology

In the context of this research, the following methods were used: generalization of the experience of professional training for future teachers, analysis of specialized literature and psychological-pedagogical literature, synthesis, and systematization – to develop innovative technologies and methods for forming the professional competence of teachers; generalization and systematization of research materials, which allowed us to identify the state of the problem of applying innovative technologies in education; empirical methods: pedagogical observation, surveys of lecturers, teachers, students, and a pedagogical experiment to verify the effectiveness of the developed pedagogical conditions; methods of mathematical statistics, which we used during the research to establish quantitative dependencies between phenomena and processes and to process the obtained data.

Experimental Research Work aimed at studying the effectiveness of the formation of professional competence in future teachers using innovative technologies was conducted in several interconnected stages: preparatory stage, diagnostic stage, and formative stage.

Participants in the Experimental Research Work included 140 students, 27 lecturers from higher education institutions, and 28 school teachers.

We examined the formation of the professional competence of future teachers through innovative technologies as a dynamic ability of teachers to solve professional tasks in general education, linking it with their future professional-pedagogical activities that encompass the following components: motivational, activity-based, and project-technological.

The level of formation of these components (sufficient, average, high) in the process of solving professional tasks characterizes the effectiveness of teacher professional training.

In the course of the research, we developed pedagogical conditions that ensure the formation of the professional competence of future teachers through innovative technologies.

At the formative stage of the experiment, where respondents were divided into experimental groups (EG) and control groups (CG) and the Student's t-test was used (for independent variables), the statistical verification of incoming control data showed that the CG and EG were homogeneous.

The results of the comparative analysis of the diagnostic and formative stages of the experiment indicated significant changes across all components of professional competence, namely that respondents

in the EG had a higher level of professional competence, achieved better results, and were better prepared to perform professional duties in schools.

The results of surveys conducted among lecturers, teachers, and students of higher education institutions confirmed the effectiveness of the proposed innovations and the implementation of pedagogical conditions that encouraged them to use innovative technologies. The role of lecturers in higher education institutions also changed concerning managing the process of personal development through cooperation and learning, interaction, and examining pedagogical situations through the use of innovative technologies, fostering a creative search for effective solutions to professionally oriented tasks.

Results and Discussion

The content of the main concepts of the research and the main types of innovative technologies.

In our research, we will clarify the concepts of "professional competence of the teacher," "competency-based approach in education," and "innovative technologies."

A derived element of general cultural competence is the professional competence of the teacher. The culture of a person dominates over the competence of the individual, as it encompasses the degree of development and improvement of the personality, including memory and imagination qualities, character, and intellect, which a person acquires during education and upbringing.

The leading pedagogical category that entails the effective creation of certain innovative pedagogical conditions in the educational process is the competency-based approach in education. It is precisely the innovative pedagogical conditions that ensure the formation of the ability to solve professional tasks based on the acquired knowledge, skills, and competencies.

Innovative technologies are defined as a set of methods and tools in the educational process aimed at achieving a predicted outcome, characterized as a process of direct and indirect interaction between students and teachers that ensures personal-oriented interaction. The teacher transforms from a transmitter of scientific information into an organizer of students' cognitive processes, becoming their advisor and assistant (Balalaieva et al., 2023).

In our research, we will adhere to the view that the formation of teachers' professional competence occurs in the higher education process through innovative technologies aimed at a competency-based approach. This approach shifts the focus toward developing and forming the ability of future teachers to creatively apply their acquired experience and knowledge and to act innovatively in practical activities, moving away from merely accumulating standardized skills, abilities, and knowledge.

The complex of three interconnected components constitutes "innovative technology":

1. Active methods for forming teachers' professional competence involve modern teaching methods that engage students in the learning process through interaction rather than relying solely on passive reception of material.
2. Modern content delivered to teachers should foster the development of competencies that align with contemporary business practices, rather than focusing solely on acquiring subject knowledge. It should be presented in the form of well-structured multimedia educational materials.
3. Organizational, technological, informational, and communicative components include a modern learning infrastructure that allows for the effective use of the advantages of distance learning formats.

Today, various pedagogical innovations are applied in the educational process to foster teachers' professional competence. We will highlight the most characteristic and essential innovative technologies (Sulym et al., 2023).

1. Information and communication technologies are essential for forming teachers' professional competence during subject-based education. The content of the educational process involves the implementation of information and communication technologies, integrating various subject areas with computer science, which leads individuals to understand the processes of informatization in society, the informatization of human consciousness, and its professional aspect. The experience of using information and communication technologies in forming teachers' professional competence has shown that:

   - The informational environment of an open-type educational institution significantly increases personal motivation. This environment includes various forms of distance education when studying subject disciplines, especially through project-based learning.
   - Informatization of education alleviates psychological tension in educational communication by transitioning to more objective relationships between "student – computer – teacher", as opposed to subjective relationships between "teacher – student". This increases the share of creative work, enhances work efficiency, and expands opportunities for obtaining additional education, leading to a conscious and purposeful choice of a prestigious career direction in the future.
   - The informatization of teaching enhances personal productivity and increases the overall information culture of educators. Among the main types of digital technologies, the following can be highlighted: cloud technology, mobile learning, gamification, online courses, web quests, etc. (Tran, 2024).

Mobile learning technology is the most popular for forming teachers' professional competence in the field of education. It provides the opportunity for knowledge exchange and productive, convenient collaborative work. Participants in the educational process can share materials remotely using wireless networks, and infrared functions of pocket personal computers can transmit data among mobile devices within a group of learners. Cloud technologies offer convenient network access, allowing for information use with minimal management efforts and enabling the storage of large amounts of information. In other words, the cloud facilitates data processing, distribution, and storage.

2. Information and analytical support for the educational process in forming teachers' professional competence and managing the quality of education for individuals. The information-analytical approach to managing the quality of education is an innovative technology that allows for an unbiased and objective tracking of each teacher's involvement, either individually or as part of a group.
3. Student-centered technologies in forming teachers' professional competence place the student at the center of the entire higher education system. These technologies ensure safe, comfortable, and conflict-free conditions for human development, facilitating the realization of natural potentials. In this approach, the teacher's personality is not merely a means to achieve any abstract goal but is considered the goal of the educational system itself.
4. Monitoring the intellectual development of teachers in forming professional competence involves constructing graphs and testing performance dynamics to analyze and diagnose the quality of each individual's education.
5. The leading mechanism for forming the professional competence of modern teachers is educational technologies, which are an integral factor in current teaching conditions. These technologies involve engaging students in additional forms of personal development, such as participation in creative centers, cultural and mass events, theaters, and national traditions.
6. Didactic technologies, as a condition for forming the professional competence of modern teachers and developing the educational process within an educational institution, provide opportunities to implement well-established techniques as well as new ones – group, differentiated teaching methods, project preparation and defense, games, "consultant" systems, and training using technical means, among others.
7. Psychological and pedagogical support for forming the professional competence of modern teachers involves implementing innovative technologies in the educational process. This includes the use of innovations, scientific-pedagogical justification, analysis with methodological recommendations, seminars, and consultations in the educational field with leading specialists. Innovative teaching

methods for forming modern teachers' professional competence through the introduction of innovative technologies include interactive and dialogic learning, which involves direct communication between students and teachers (Tanska et al., 2024).

Identifying pathways that will enable the formation of practical experience and knowledge components for future work in the professional field during the professional preparation of modern teachers is essential for developing an innovative and effective system for training future educators.

The educational policies of all civilized countries around the world prioritize improving the quality of the modern educational paradigm by transforming traditional teaching methods into innovative technologies, which primarily aid the development of reproductive learning pathways. In contrast, innovative technologies emphasize the formation of creative thinking during classes; actively engaging all participants in the higher education process in cognitive activities; and productively searching for solutions to set tasks. Focusing students' attention on improving and developing fundamental skills is a crucial element of innovative learning, where social skills and productive thinking are directed at establishing interpersonal connections. With this approach, it is important to carry out training consistently at any age to remain competitive professionals in the modern labor market and to acquire professional mobility (Sovhira et al., 2023).

The increase in the prestige of higher education among society in the context of globalization and the reform of higher education is possible through the renewal of the tasks and goals of higher education institutions in accordance with societal values and the modern market's demand for highly qualified teachers. These teachers must be able to quickly adapt to circumstances, possess flexible thinking, have strong communication skills, and have a high level of knowledge. They should not only formulate their thoughts but also confidently express them. Additionally, they should know how to integrate information and communication technologies into the educational space and implement innovative technologies into the higher education teaching process (Holub & Goroshkina, 2023).

Through the education of a new generation of specialists in a particular field, the formation of a future close to ideal is envisioned within higher education institutions. This involves the creation of human capital (skills, abilities, knowledge) and social capital (a stable civic position, mentality, cultural and general values), which will be used for the benefit of the state (Kremen, 2023). The improvement of the educational process in higher education institutions primarily involves the implementation of modernized methods, forms, techniques, and means of teaching during the learning activities, as well as encouraging scientific justification for the proposed innovative teaching technologies.

We emphasize the importance of reorienting towards European standards in the modern educational space while preserving national educational traditions (Leleka et al., 2022).

We emphasize the importance of improving higher pedagogical education, continuous teacher training, analyzing the quality of the educational process, and fostering professionalism and practical skills in educators, as well as the necessity for future teachers to learn how to apply innovative technologies in their lessons.

Addressing the identified issues in the process of professional training for modern teachers allows for the development of practical experience and knowledge components for future work in their professional field; it helps to create an innovative and effective system for training future educators and expands the theoretical and methodological foundations of a student-centered approach to learning. Regardless of the requirements placed on future teachers during their professional training, an important factor is the alignment of their development level with the technological, informational, sociocultural progress, and contemporary ideological trends of modern society, as well as with the traditional canons of the higher education process (Drozich et al., 2023).

We emphasize the necessity and importance of utilizing the principles of organizational development theory in professional competence, which is currently relevant, particularly the tenets of personal self-development theory, to ensure effective collaboration between future teachers and higher education institutions (under the guidance of educators) (Knysh et al., 2023).

The process of professional training for educators, specifically teachers, provides the opportunity to develop practical experience and knowledge necessary for future work in the professional field and to create an innovative, effective system for preparing future educators. It involves nurturing a creative personality capable of self-improvement and self-development, and carrying out productive activities using innovative technologies over an extended period to form and enhance professional competence. This approach will help solidify acquired knowledge, develop quality professional skills in future educators, and enhance the professional competence of teachers through innovative technologies.

Thus, the complexity of forming a teacher's professional competence lies in creating innovative, supportive conditions for the student's potential development, while the result of professional training is determined by the specialist's engagement in the social and educational space, their competitiveness in the modern labor market, which contributes to better motivation and adaptation in society and the professional sphere.

We focused on the fact that during the educational process in higher education, the formation of teachers' professional competence occurs based on personal-oriented, competence-based, and activity-based approaches, which shape the educational environment of the higher education institution, allowing students to practice the relevant skills and knowledge they have acquired in a real environment.

Therefore, it is essential to concentrate on the introduction and search for effective means to reorient the educational process towards European standards for educators for effective modernization of higher education. This process successfully applies the acquired knowledge about forms, approaches, means, methods, and innovative technologies in their practical activities at the teacher's workplace, where the application of innovative teaching technologies is a key element in ensuring a successful educational process, allowing students to acquire personal and professional characteristics.

Innovative educational technologies are new learning technologies that are adapted to the educational space and have emerged in the course of pedagogical activity, or already known technologies that have found applications in new conditions (Shuliak et al., 2022).

The main innovative educational technologies necessary for forming teachers' professional competence.

The main innovative educational technologies necessary for forming teachers' professional competence include:

- **Utilization of the latest advancements in information technology** – to activate kinesthetic, auditory, and visual channels of information perception in the application of computer technologies during classes.
- **Application of the case method in higher education** – involves the teacher using a fictional or real situation to analyze possible developments and serve as a discussion object.
- **Teamwork** – helps develop creative thinking and communication skills during joint activities, involving all participants in the educational process in solving a common problem.
- **Problem-based learning** – facilitates quality assimilation and processing of necessary material and encourages active cognitive activity in students as they independently search for knowledge needed to solve the problem set by the teacher.
- **Games** – involve creating a game environment where the object takes on the role of the teacher in the learning process when it becomes the subject; role-playing simulations of real professional activities in specific situations increase interest in the subject and encourage students to find new ways to solve the tasks set.

- **Learning based on prior experience** – relates students' previous experiences to theoretical information about the subject, allowing for parallels between practical activities and theoretical components.
- **Individual learning** – through the development of educational programs and curricula, allows students to create their own paths to assimilate information that correspond to their capabilities, age characteristics, and interests.
- **Project creation** – involves students developing their own product under the guidance of the teacher in the process of individual or group work, alongside the parallel development of general and specialized professional competencies.

Innovative teaching technologies in modern education aim to activate students' cognitive activities and, through non-standard methods and approaches, reveal their potential (Koval & Masliuk, 2024).

The role of digitalization in education in forming teachers' professional competence.

Educational institutions increasingly apply new innovative educational technologies necessary for forming teachers' professional competence and technologies to improve the quality of education. One of these is the digitalization of education, the digital transformation of the entire educational system and the educational activities of individual higher education institutions (Kulish et al., 2020).

Active use of information and communication technologies characterizes modern education. Information and communication technologies provide students with access to global resources on the Internet; enable computer-based knowledge diagnostics; implement technologies for processing audiovisual information and digital educational tools; and facilitate the creation of new teaching tools within a unified information and educational environment to enhance learning quality.

Modern digital educational resources are characterized by visibility, interactivity, and provide diverse learning information while allowing for objective knowledge assessment, among other things.

In the context of the informatization of education, the creation and use of new teaching tools are relevant. These digital educational resources (information sources) are aimed at achieving the goals and objectives of modern education and contain textual, graphic, speech, video, photo, and other information presented in digital form.

Multifunctional digital educational resources contribute to forming teachers' professional competence, allowing for the placement of large volumes of information; rapid access and search for necessary information; visual presentation of many complex phenomena and processes; and the use of various graphic designs, etc. (Filonenko & Tsukanova, 2023).

The digitalization of education in forming teachers' professional competence provides each student, the future educator, with additional opportunities and quality preparation to develop competencies for professional activity in the following areas:

- Acquisition of the fundamentals of emotional, intellectual, and physical labor activities, practical communication experience, contributing to the formation of professional competence, and the essential intellectual skills necessary for everyday work, self-education, and lifelong learning;
- Acquisition of professional information for forming professional competence, which constitutes the foundation of a person's worldview, contributes to the development of a scientific image of the world, and ensures guidance in choosing the future practical field of activity;
- In accordance with the digitalization of modern society, the formation of teachers' professional competence and the development of the educator's personal potential through the acquisition of creative activity experience (Filonenko, 2024).

With the transition of education to a personalized pedagogy, the current state of forming the professional competence of modern teachers and the entire educational field requires educators to implement innovative technologies, anticipating the development of children's individual abilities and the inclusion of non-traditional methods and approaches in the educational process.

Let's highlight the main tasks for the successful work of a modern teacher:

- To apply innovative technologies for individualized learning trajectories;
- To be knowledgeable about effective modern innovative technologies for forming the professional competence of contemporary educators;
- To be able to combine innovative approaches with traditional ones in their professional activities, drawing on the experience of innovative educators;
- To support the educational process in accordance with established value orientations;
- To implement and develop innovations in working with children;
- To solve pedagogical challenges;
- To create a developmental environment for children's learning using innovative didactic materials;
- To understand how to implement non-standard approaches and new ideas in the process of forming professional competence through innovative technologies;
- To foster a positive climate in the educational community;
- To facilitate communication with other participants in the educational process (parents, children, educators) (Kostyk & Oliynyk, 2024).

Effectiveness and Advantages of Using Immersive Technologies in Forming Teachers' Professional Competence.

With the comprehensive activation of human cognitive activity, there is an increasing involvement of powerful multimedia resources in the rational composition of contemporary disciplinary courses (Tkach, 2017). The effectiveness of using immersive technologies in various forms of the educational process is determined by the profiling of the institution and its educational policy, as well as the configuration of individual educational trajectories, which enhance the quality of programmed learning outcomes with a clarification of specialization (Stratan-Artyshkova et al., 2022).

A tool that contributes to improving the acquisition of learning material today is virtual reality, which takes place in both practical classes and traditional lectures at higher education institutions, as well as in school classrooms. This is a crucial component of innovative education and the formation of modern teachers' professional competence, particularly in the professional development of educational staff.

The new approach to acquiring and delivering practical and theoretical skills in educational institutions of all levels is virtual reality, the application of which in educational settings has important advantages:

- **Increased interactivity of the educational process:** Virtual reality promotes better acquisition of skills and knowledge and allows learners to actively interact with the learning material.
- **Enhanced accessibility of learning:** Virtual reality allows for the creation of simulated situations, providing accessible and safe learning practice (Umanets, 2023);
- **Possibility of simulating real situations:** Virtual reality allows for the creation of realistic simulations for training, such as equipment servicing, medical procedures, flying, and more.
- **Cost reduction:** The use of virtual reality can decrease costs related to infrastructure, equipment, and learning materials, as some training tasks can be virtualized.
- **Increased motivation:** Virtual reality can be engaging and interesting for students, enhancing their motivation to learn. It is important to note that virtual reality cannot replace the teacher in the educational process; its technologies only complement the learning experience.

VR applications improve the effectiveness and motivation of learning and the entire educational process by providing relevant and contextual outcomes to enhance education, helping to focus the user's attention

on specific tasks and allowing teachers to overlay visual effects, information, and various forms of content onto traditional boards, improving student performance (Shetelya et al., 2023).

While working in schools, modern teachers must possess innovative practices to implement innovative teaching models in their practical activities. These include synchronous and asynchronous learning, adaptive learning, blended learning, distance learning, self-directed learning, mobile and cloud learning, flipped classrooms, virtual classrooms, gamification, personalization, e-learning management systems, digital storytelling, and course management systems (CMS), among others. Therefore, special attention should be paid to the digital training of modern teachers.

The professional competence of teachers is fostered by the digital environment (electronic, information-educational environment) of higher education institutions, which includes modern equipment, free Wi-Fi zones, computer labs, electronic learning resources, software, and more.

It is also advisable to utilize created repositories, electronic scientific journals, and electronic readers in higher education institutions for the formation of teachers' professional competence. Additionally, conducting conferences, competitions for student research papers, and seminars in various communication modes can be beneficial.

Moreover, for the formation of teachers' professional competence, additional means of information interaction, such as social networks and discussions of scientific and educational issues in communication chats and interest-based scientific groups, are used. This undoubtedly expands the information educational space of higher education institutions and contributes to the development of teachers' professional competence, ensuring the quality of education in both universities and schools (Kuchai et al., 2022).

We have identified the competency-based approach as one of the main approaches to forming the professional competence of teachers because, in the training of future teachers, this approach facilitates the transfer of practical and theoretical knowledge from the educator to the learner, fostering readiness for professional activity.

The formation of the professional competence of teachers, scholars, and researchers is one of the fundamental components of education development. This includes equipping relevant laboratories, implementing STEM education, supporting future leaders in global science and Hi-tech, and elevating the status of teachers as the professional elite of the nation (Shkarlet, 2022).

The experiment.

In justifying the process of forming the professional competence of teachers through innovative technologies, we focused on the specificity of the research topic, referencing scholars' developments regarding the structure of professional competence and the issues of implementing a competency-based approach and their solutions. We regarded the professional competence of future teachers as a combination of basic professional competencies (reflective, psychological-pedagogical), key competencies (information-communication, communicative), and special competencies (didactic, methodological, subject-specific).

Currently, innovative technologies that are independent of the components and technological, technical, and software environments in which they are implemented need to be integrated into the educational process.

The experimental research aimed at studying the effectiveness of the formation of professional competence in future teachers using innovative technologies based on identified pedagogical conditions was conducted in the following interconnected stages: preparatory stage; ascertaining stage; formative stage.

The experimental study involved 140 students, 27 higher education institution teachers, and 28 school teachers (Fig. 1).

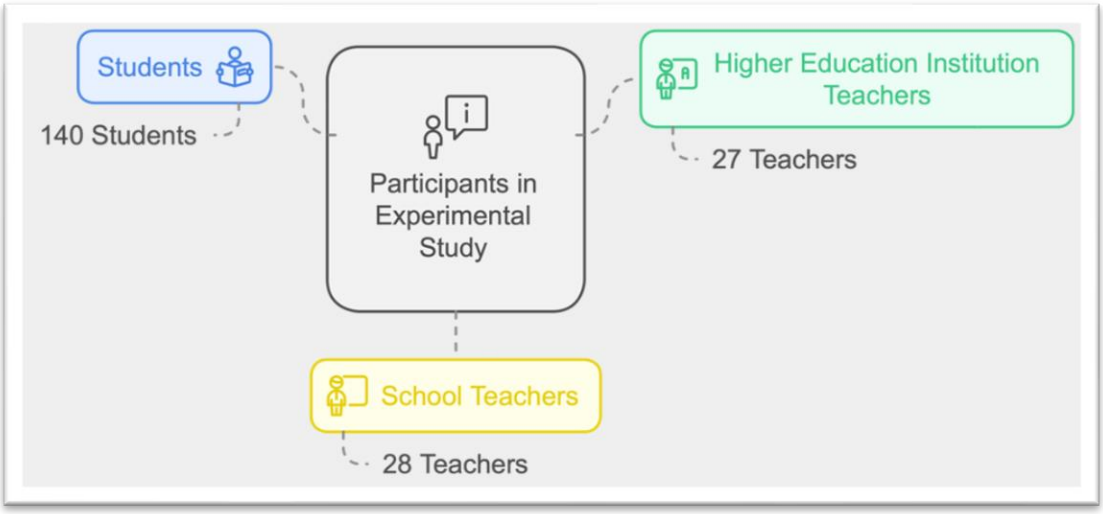

Figure 1. Participants in Experimental Study.

The research into the formation of components – motivational, operational, and design-technological – during the ascertaining stage showed that motivation to form the professional competence of future teachers in each individual is determined by the desire to experience joy from high results and successful activities, driven by internal reasons of the respondents; the quality of education was only 62% among respondents. Only 38% of graduates received satisfactory grades. The average score was 3.7% (Fig. 2).

Figure 2. Quality of Education and Graduate Grades.

The analysis of the formation of motivational factors, moral-will, cognitive, organizational components, teaching abilities in educational institutions, and communication skills in pedagogical activity revealed that (Fig. 3):

- 10% of respondents had a high level of formed professional competence;
- 32% of respondents had a medium level of formed professional competence.
- 58% of respondents had a low level of formed professional competence.

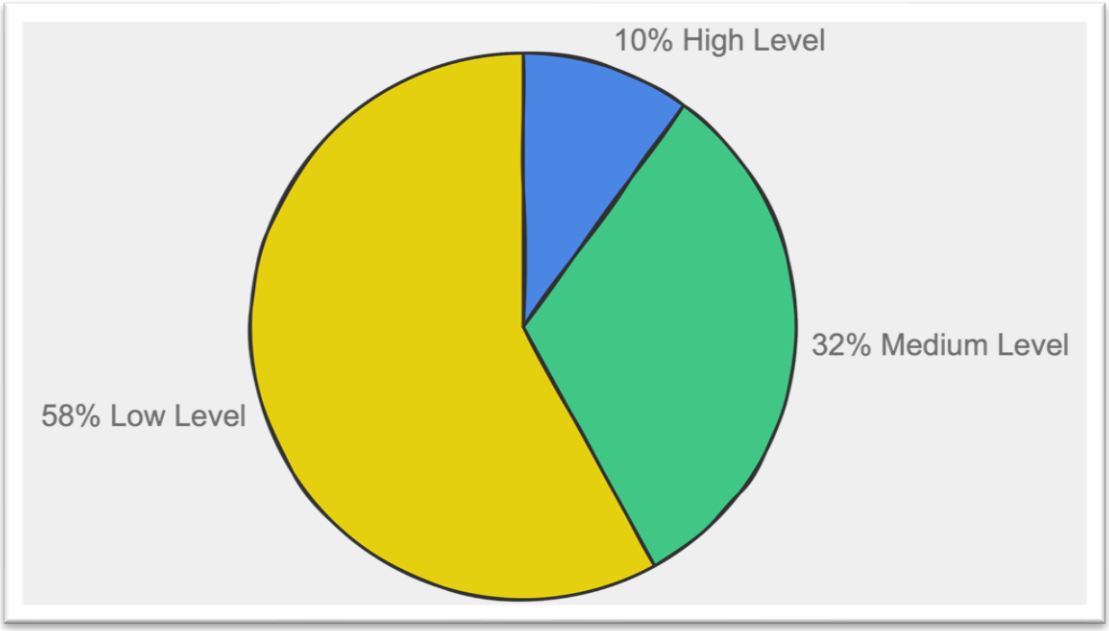

Figure 3. Distribution of Professional Competence Levels Among Respondents.

The results of surveys among higher education institution teachers, students, and school teachers confirmed the insufficient level of professional competence formation in future teachers.

Thus, we concluded that changes in teacher training are necessary.

When effectively utilizing innovative technologies in the educational processes of schools and universities preparing teachers, a crucial aspect is the development of a methodological environment that includes methodological recommendations, instructions for task execution, educational-methodical manuals, etc.

To form the professional competence of future teachers using innovative technologies, we employed the information educational environment of the educational institution, distance learning systems, electronic educational-methodical complexes, blogs, personal web pages, web quests, search engines, cloud technologies, social services, etc.; informational and analytical support for the educational process in forming teachers' professional competence; personality-oriented technologies; monitoring teachers' intellectual development; educational technologies; didactic technologies; and psychological-pedagogical support for the formation of modern teachers' professional competence.

We considered the formation of professional competence in future teachers through innovative technologies as a dynamic ability of teachers to solve professional tasks in general education, with professional-pedagogical future activity combining the following components: motivational, operational, and design-technological.

The level of formation of the specified components (sufficient, medium, high) in the process of solving professional tasks characterizes the effectiveness of teacher professional preparation.

During the research, to address these issues, we developed pedagogical conditions that ensure the formation of future teachers' professional competence using innovative technologies: actualization of the developmental potential of the educational innovative environment of higher education institutions; mastering by teachers the peculiarities of the methodology for forming the professional competence of

future teachers using innovative technologies; and the activation of support for teachers' independent work resources through innovative technologies.

We developed directions for the methodological support of forming the professional competence of future teachers using innovative technologies: engaging teachers, students, and school teachers in actively using innovative technologies in the educational process of educational institutions; enriching databases, knowledge banks; creating complexes (educational-methodical, electronic); developing virtual education; filling information educational systems; developing control methods and interactive teaching methods; monitoring the quality of the educational process; enhancing the qualifications of teachers in applying innovative technologies to form the professional competence of future teachers; and adhering to academic integrity.

In the formative stage of the experiment, where we distributed respondents into experimental groups (EG) and control groups (CG) and applied the Student's t-test (for independent variables), the statistical verification of the initial control data showed that the CG and EG were homogeneous.

The diagnosis of the levels of formation of motivational and operational components involved determining the level of motivation and professional knowledge of both theoretical and practical nature in the process of forming the professional competence of future teachers using innovative technologies. The analysis of the experimental data revealed that the respondents in the EG (with minor differences between the initial control results) demonstrated a significantly greater increase.

The number of respondents with a high level of knowledge in the EG increased from 9% to 18%, and those with a medium level of knowledge increased from 48% to 68%, while the number of respondents with a low level decreased by 29% (in the CG, it only decreased by 7%) (Fig. 4).

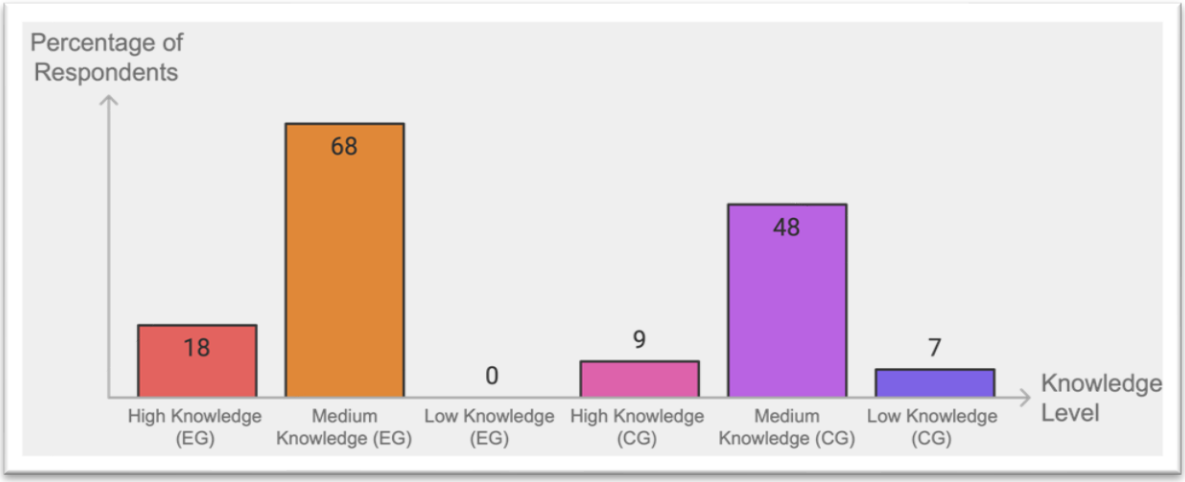

Figure 4. Changes in Knowledge Levels of Respondents.

Statistical verification conducted using the Student's t-test confirmed a significance level of less than 1%, with df = 108, t_exp = 2.68, which lies between $p < 0.001$ (3.381) and $p < 0.01$ (2.621). The research findings indicate that, under the influence of the developed pedagogical conditions, both current teachers and future teachers acquire a higher level of professional competence through innovative technologies.

The study of the level of formation of the design-technological component was based on self-assessment of readiness for self-development and pedagogical assessment by the respondents (showing an 8% increase in high levels in the EG, while the CG showed a 3% increase in high levels; we observed a 19% increase in medium levels in the EG, while the CG had an 11% increase).

The experimental work demonstrated that the use of innovative technologies for forming the professional competence of future teachers based on the pedagogical conditions developed during the experimental work significantly impacted motivation for using innovative technologies; development of prestige motives, communicative and professional motives; awareness of the need to use innovative technologies; interest in forming professional competence through implementing innovative technologies; responsibility for the results of professional activity; and the ability to determine pedagogically appropriate means of innovative technologies, conducting research using innovative technologies; developing and applying innovative technologies in future pedagogical activities.

At the summarizing stage, we summarized the obtained results, processed and systematized experimental data using mathematical statistics methods, formulated conclusions, and identified prospects for further research.

It has been proven that the result of preparing future teachers in higher education using innovative technologies is professional competence that integrates motivational, operational, and design-technological components, reflecting the ability and readiness of teachers to effectively engage in professional-pedagogical activities in schools.

Experimental evidence demonstrates that implementing the developed pedagogical conditions for forming the professional competence of future teachers using innovative technologies in higher education institutions contributes to: activating the reflective position, the educational process; developing self-education skills; enhancing the development of pedagogical abilities and professional interest; increasing teachers' motivation to acquire educational material and apply knowledge; mastering innovative technologies in subsequent professional activities and the methodology of their application; and forming teachers' skills to analyze authors' programs and innovative technology tools, and reasonably choose those that correspond to each individual's level of professional competence.

Comparative analysis results between the ascertaining stage and the formative stage of the experiment confirmed that across all components of professional competence, significant changes were evident, particularly that respondents in the EG possessed a higher level of professional competence, achieved higher results, and were better prepared to fulfill their professional duties in schools.

Results from surveys of teachers, educators, and students from higher education institutions affirm the effectiveness of the proposed innovations and the implementation of pedagogical conditions that encouraged them to utilize innovative technologies. The role of higher education institution teachers has also changed concerning managing the process of personality development through cooperation and learning, interaction, examining pedagogical situations using innovative technologies, and creatively searching for effective solutions to professionally oriented tasks.

Conclusions

An analysis of the content of the main concepts of the research has been conducted, and the main types of innovative technologies have been identified. Pathways have been shown that, in the process of professional training of modern teachers, will enable the formation of practical experience and knowledge components for further work in the professional field and the development of an innovative and effective system for preparing future educators. The main innovative educational technologies necessary for forming the professional competence of teachers have been identified.

The role of digitalization in education in forming the professional competence of teachers has been highlighted, as well as the effectiveness and advantages of using immersive technologies in this process.

Research and experimental work have been carried out to study the effectiveness of forming the professional competence of future teachers using innovative technologies based on defined pedagogical

conditions, which were conducted in three interrelated stages: preparatory stage; ascertaining stage; formative stage.

The experimental work involved students, faculty members of higher education institutions, and school teachers.

The formation of professional competence of future teachers through innovative technologies has been viewed in connection with the dynamic ability of teachers to solve professional tasks of general education, linked to their future professional-pedagogical activities, which combines such components as motivational, activity-oriented, and design-technological.

The level of formation of defined components (sufficient, average, high) in the process of solving professional tasks characterizes the effectiveness of the teacher's professional training.

In the course of the research, pedagogical conditions were developed to ensure the formation of the professional competence of future teachers through innovative technologies.

In the formative stage of the experiment, where respondents were divided into experimental groups (EG) and control groups (CG) and the Student's t-test was used (for independent variables), statistical verification of the incoming control data showed that CG and EG are homogeneous.

The results of the comparative analysis of the ascertaining and formative stages of the experiment indicated that significant changes are observed in all components of professional competence, namely, respondents in the EG have a higher level of professional competence, achieved higher results, and are better prepared to perform professional duties in schools.

The results of surveys of faculty members, teachers, and students of higher education institutions confirm the effectiveness of the proposed innovations and the introduction of pedagogical conditions that encouraged the use of innovative technologies.

Moreover, the role of higher education faculty members has changed concerning managing the process of personal development through cooperation and learning, interaction, examining pedagogical situations through the use of innovative technologies, and creatively seeking effective solutions to professionally-oriented tasks.

Further research and improvement are needed regarding the implementation of open educational resources in the educational process of schools and higher education institutions, the clarification of methods for assessing teachers' readiness for professional activity, and the criteria for the effectiveness of innovative technologies.

Bibliographic references

Balalaieva, O., Mochan, T., Hryhorenko, T., Andreikova, I., Paltseva, V., & Podkovyroff, N. (2023). Innovative pedagogical technologies – the most important resource in modernizing the training of a modern specialist. *Amazonia Investiga, 12*(63), 67–76. https://doi.org/10.34069/AI/2023.63.03.6

Balukh, M. (2024). Formation of Professional Competence of Future Physical Culture Teachers by Means of Innovative Health Care Technologies. *Pedagogical Discourse, (35),* 19-23. https://doi.org/10.31475/ped.dys.2024.35.03 http://ojs.kgpa.km.ua/index.php/peddiscourse/article/view/1200/1082

Drozich, I., Drobin, A., Skrypka, I., Mamchych, O., Mykhailenko, O., & Kurach, M. (2023). The role of education in the innovative society. *Amazonia Investiga, 12*(64), 45–56. https://doi.org/10.34069/AI/2023.64.04.4

Filonenko, O. V. (2024). Formation of linguistic and cultural competence of future specialists using information and communication technologies. *Academic Notes. Series: Pedagogical Sciences, (215)*, 96-99. https://doi.org/10.36550/2415-7988-2024-1-215-96-99

Filonenko, O., & Tsukanova, N. (2023). Features of the formation of digital competence of future teachers of primary grades in an institution of higher education. *Pedagogical Sciences: Theory, History, Innovative Technologies, 8-9*(132-133), 155-164. https://acortar.link/RiGUfb

Holub, N., & Goroshkina, O. (2023). Methods of distance learning of the Ukrainian language. *Ukrainian Educational Journal, (4)*, 148–158. https://doi.org/10.32405/2411-1317-2022-4-148-158

Kartashova, Zh. Yu., & Kuziv, M. V. (2024). Innovative techniques for the formation of professional competences of future music teachers in the process of studying music–theoretical disciplines. *Pedagogical Academy: Scientific Notes, (8)*. https://doi.org/10.5281/zenodo.12665781

Knysh, I., Budanova, O., Vakulenko, S., Syrotina, O., & Popychenko, S. (2023). Innovative educational technologies as a way of higher education enhancement. *Amazonia Investiga, 12*(68), 21–32. https://doi.org/10.34069/AI/2023.68.08.2

Komar, O. A. (2024). Digital competence of the future primary school teacher: preparation for the mathematics lesson. Academic Notes. *Series: Pedagogical Sciences, (215),* 51-55. https://doi.org/10.36550/2415-7988-2024-1-215-51-55

Kostyk, L., & Oliynyk, M. (2024). Modern innovative technologies of corrective work in the professional activities of the speech therapist teacher. *Psychology Travelogs, (3)*, 219–228. https://doi.org/10.31891/PT-2024-3-21

Koval, V., & Masliuk, K. (2024). Professional training of future teachers of Ukrainian language and literature using innovative educational technologies. *Youth and Market, (6)*, 18-25. https://doi.org/10.24919/2308-4634.2024.307757

Kremen, V. (2023). Teacher training: Challenges and responses: According to the results of scientific report at the meeting of the Strategic Session of the Heads of Higher Education Institutions, March 1, 2023. *Herald of the National Academy of Educational Sciences of Ukraine, 5*(1), 1-6. https://doi.org/10.37472/v.naes.2023.5104

Kuchai, O., Hrechanyk, N., Pluhina, A., Chychuk, A., Biriuk, L., & Shevchuk, I. (2022). World Experience in the Use of Multimedia Technologies and the Formation of Information Culture of the Future Primary School Teacher. *International Journal of Computer Science and Network Security, 22*(3), 760-768. https://doi.org/10.22937/IJCSNS.2022.22.3.100

Kulish, A., Radul, V., Haleta, Y., Filonenko, O., & Karikh, I. (2020). The Newest Digital Technologies in Education and The Prospects of Their Implementation in Ukraine. *Propósitos Y Representaciones, 8*(SPE2), e684. https://doi.org/10.20511/pyr2020.v8nSPE2.684

Leleka, V., Zabiiaka, I., Tsviakh, O., Grubi, T., & Vytrykhovska, O. (2022). Innovative approaches to teaching students in the modern educational information environment in the USA and Great Britain. *Amazonia Investiga, 11*(60), 156–166. https://doi.org/10.34069/AI/2022.60.12.17

Malakhova, M., & Ovcharenko-Pieshkova, O. (2024). Preparation of the future teachers in the musical art for the forming of artistic and creative competence of the students by means of innovative technologies. *Current Issues of Humanitarian Sciences, 2*(75), 268-274. https://doi.org/10.24919/2308-4863/75-2-42

Marusynets, M., Vovkochyn, L., Yakymenko, S., Tkachuk, N., & Tymchenko, A. (2022). Innovative educational technologies in the system of specialist's professional training. *Amazonia Investiga, 11*(60), 177–186. https://doi.org/10.34069/AI/2022.60.12.19

Shetelya, N., Oseredchuk, O., Cherkasov, V., Kravchuk, O., Yarova, L., & Kuchai, O. (2023). Competency approach in preparing professionals in an innovative educational environment in higher education. *Revista Conrado, 19*(S3), 298-307. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3512

Shkarlet, S. M. (2022). *Education of Ukraine under martial law. Innovative and project activity: Scientific and methodical collection*. Kyiv-Chernivtsi: Bukrek, 140 p. https://acortar.link/019jd4

Shuliak, A., Hedzyk, A., Tverezovska, N., Fenchak, L., Lalak, N., Ratsul, A., & Kuchai, O. (2022). Organization of Educational Space Using Cloud Computing in the Professional Training of Specialists. *International Journal of Computer Science and Network Security, 22*(9), 447-454. https://doi.org/10.22937/IJCSNS.2022.22.9.58

Sovhira, S., Dushechkina, N., Balokha, A., Borysenko, N., & Ieresko, O. (2023). Ecologization of education in the innovative space of higher education. *Amazonia Investiga, 12*(67), 115–126. https://doi.org/10.34069/AI/2023.67.07.11

Stratan-Artyshkova, T., Kozak, Kh., Syrotina, O., Lisnevska, N., Sichkar, S., Pertsov, O., & Kuchai, O. (2022). Formation of New Approaches to the Use of Information Technology and Search For Innovative Methods of Training Specialists within the Pan-European Educational Space. *International Journal of Computer Science and Network Security, 22*(8), 97-104. https://doi.org/10.22937/IJCSNS.2022.22.8.13

Sulym, V., Melnykov, A., Popov, M., Vechirko, O., & Malets, D. (2023). Improving education through implementation of information technologies into the educational process. *Amazonia Investiga, 12*(68), 281–293. https://doi.org/10.34069/AI/2023.68.08.26

Tran, E. (2024). *15 innovative teaching methods with guide and examples | Best in 2024*. AhaSlides. https://ahaslides.com/blog/15-innovative-teaching-methods/

Tanska, V. V., Hubarieva, D. V., Androschuk, I. V., Logai, V. A., & Pinchuk, L. M. (2024). Innovative technologies in the modern education system. *Bulletin of Science and Education, (22*), 1494-1508. https://doi.org/10.52058/2786-6165-2024-4(22)-1493-1507

Tkach, Yu. (2017). VR-technology as a method and means of training. *Educational Discourse, (3-4)*, 309-322. https://od.kubg.edu.ua/index.php/journal/article/download/444/392/1251

Umanets, V. O. (2023). Digitalization of educational and administrative processes in vocational (vocation-technical) education institutions. *Science and Technology Today, 2*(16), 321-336. http://perspectives.pp.ua/index.php/nts/article/download/3822/3843

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.5
Cómo citar:
Dushechkina, N., Yatsyna, S., Malyk, Y., Shayner, H., Tyshkovets, M., & Nykytenko, O. (2024). Interpersonal interaction strategies for the development of communication skills in university education. *Revista Eduweb*, *18*(4), 68-88. https://doi.org/10.46502/issn.1856-7576/2024.18.04.5

Interpersonal interaction strategies for the development of communication skills in university education

Estrategias de interacción interpersonal para el desarrollo de habilidades comunicativas en la formación universitaria

Nataliia Dushechkina
https://orcid.org/0000-0002-4203-7122
nataxeta74@gmail.com
WoS Researcher ID: D-8642-2019
Candidate of Pedagogical Sciences, Associate Professor, Associate Professor of the Department of Chemistry and Ecology, Pavlo Tychyna Uman State Pedagogical University, Ukraine.

Svitlana Yatsyna
https://orcid.org/0000-0002-6319-3829
svt.yatsina@vu.cdu.edu.ua
WoS Researcher ID: AFK-5889-2022
Ph.D., in Pedagogy, Senior Teacher of the Department of Primary Education, Cherkasy Bohdan Khmelnytsky National University, Ukraine.

Yuliana Malyk
https://orcid.org/0000-0002-3295-5771
mui_27@ukr.net
WoS Researcher ID: KCX-6368-2024
Candidate of Pedagogical Sciences (Ph.D.), Associate Professor of the Department of Business Foreign Languages and International Communication, National University of Food Technologies, Ukraine.

Hanna Shayner
https://orcid.org/0000-0002-0086-5579
hanna.i.shayner@lpnu.ua
WoS Researcher ID: LDF-6953-2024
Candidate of Pedagogical Sciences, Associate Professor Assistant Professor of the Department of Foreign Languages for Engineering, Institute of the Humanities and Social Sciences, Lviv Polytechnic National University, Ukraine.

Mariia Tyshkovets
https://orcid.org/0000-0002-6976-7440
zasiekina_m@ukr.net
WoS Researcher ID: LNQ-5010-2024
Researcher of the STEM Education Department, Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, Ukraine.

Olha Nykytenko
https://orcid.org/0000-0002-7305-7812
nikitolya@i.ua
WoS Researcher ID: KJL-4483-2024
Senior Lecturer, National University of Food Technologies, Ukraine.

Recibido: 03/11/24
Aceptado: 15/12/24

Abstract

The content of interpersonal interaction, its types, main features, and role in the formation of communicative competence of the future specialist are clarified. The structure of motivation of future specialists for interpersonal interaction to form communicative competence is disclosed. The leading functions and methods of training students in creating their communicative competence are highlighted. Presented are modern information and communication technologies and communicative discursive technologies for interpersonal interaction in the formation of the communicative competence of the future specialist. The principles necessary for interpersonal interaction in the formation of the communicative competence of the future specialist are substantiated. The structure of motivation, directions, and conditions for the organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of the communicative competence of the future specialist are presented. The experimental work made it possible to talk about interpersonal interaction in the formation of communicative competence of the future specialist as a serious and necessary problem that requires a holistic study in education and professional activity. It was concluded that the developed author's method is effective, and communicative technologies are appropriate and correct for implementation in the process of professional training of a specialist for the implementation of interpersonal interaction in professional activities in the formation of communicative competence.

Keywords: interpersonal interaction, formation of communicative competence, communicative technologies, students, higher school.

Resumen

Se aclara el contenido de la interacción interpersonal, sus tipos, características principales y papel en la formación de la competencia comunicativa del futuro especialista. Se da a conocer la estructura de motivación de los futuros especialistas para la interacción interpersonal con el objetivo de formar competencia comunicativa. Se destacan las principales funciones y métodos de formación de los estudiantes en el aspecto de la formación de su competencia comunicativa. Se presentan tecnologías modernas de la información y la comunicación y tecnologías discursivas comunicativas para la interacción interpersonal en la formación de la competencia comunicativa del futuro especialista. Se fundamentan los principios necesarios para la interacción interpersonal en la formación de la competencia comunicativa del futuro especialista. Se presenta la estructura de motivación, orientaciones y condiciones para la organización y desarrollo del entorno educativo de acuerdo con los principios necesarios para la interacción interpersonal en la formación de la competencia comunicativa del futuro especialista. El trabajo experimental permitió hablar de la interacción interpersonal en la formación de la competencia comunicativa del futuro especialista, como un problema grave y necesario que requiere un estudio holístico en la educación y la actividad profesional. Se concluyó que el método desarrollado por el autor es efectivo y las tecnologías comunicativas son apropiadas y correctas para su implementación en el proceso de formación profesional de un especialista para la implementación de la interacción interpersonal en las actividades profesionales en la formación de la competencia comunicativa.

Palabras clave: interacción interpersonal, formación de competencia comunicativa, tecnologías de la comunicación, estudiantes, escuela superior.

Introduction

To a large extent, the success of democratic processes in higher education depends on the development of subject-subject relationships in the educational process between students and teachers and their interpersonal interaction based on partnership, cooperation, and dialogue. The change in the relationship between students and teachers, their social positions and roles, which is fundamental, is due to the new educational paradigm and the requirements of the time. In the world educational space, according to modern philosophical approaches, the following processes take place: a student becomes a producer and acquirer of personal knowledge; education acquires signs of continuous knowledge; the teacher is the

organizer of the process of students acquiring their own knowledge experience, educational and cognitive activity; humanistic orientation, the effectiveness of the educational process is achieved through positive interpersonal interaction of students in joint activities, in the conditions of a community united by the tasks and purpose of the educational process, taking into account the culture of each individual, the uniqueness of the position. Educational processes, through interpersonal interaction in the formation of the communicative competence of the future specialist, are justified and explained by the philosophical theories of humanistic psychology, postmodernism, and constructivism, which reveal the natural features of the cognitive activity of the individual, his interaction with the social environment, emotional and cognitive development, self-improvement under the influence of external actions. This approach attests to the important role of the individual in constructing one's own vision of the world, the important role in creating relationships with other people and oneself, perceiving the outside world, and changing the socio-economic conditions of society's development (Ravchyna, 2005).

The specificity of the work of modern specialists of various professions in the process of professional and communicative activity implements professional functions, which in the process of direct cooperation, interaction, coordination of influence on the subject, dialogue, and need to consciously penetrate the culture of the interlocutor, the ability to find constructive communication strategies without losing this own personal individuality.

One of the leading tasks of modern professional training of specialists in institutions of higher education is the formation of the competence of specialists regarding the communicative features of the field of professional activity, their interpersonal interaction in the formation of the communicative competence of future specialists, the acquisition of skills in the system of the professional, communicative environment to successfully fulfill their role, the principles of the implementation of various professional roles in the formation of communicative competence. This requires, in a specific socio-professional situation, strengthening the role of interpersonal communication in business relations; the ability of graduates of higher schools to mobilize skills, knowledge, experience; moving to the sphere of interpersonal communication from the sphere of professional realization of the life interest of a significant part of specialists; the need to find new forms of communication as a result of the development of an innovative professional sphere; solving personal problems; minimization of direct communication between colleagues, which is caused by the development of virtual forms of interaction (Rudenko, 2018).

The most important aspect of the professional competence of a specialist of any profile is communicative competence. The expansion of opportunities for professional growth of a person, globalization processes in the world, and prospects for the personal development of a specialist require interpersonal interaction with the aim of forming the communicative competence of the future specialist and require a high level of professional training and as a prerequisite for establishing productive interaction with all subjects of activity in the process of communication – the formation of communicative competence (Gusak & Smalko, 2023). The formation of communicative competence is of great importance for the development of highly organized relationships in the field of interpersonal interaction, which nowadays is characterized by superficiality, certain stress, and lack of emotions. Therefore, the relevance of the specified problem – interpersonal interaction in the formation of communicative competence of the future specialist – is undoubted for future specialists since the quality of future professional activity directly depends on their readiness and their ability to build a communicative process.

Literature Review

The work of T. Pushkar (2016) is devoted to the study of the development of personality traits and communicative competence. During the professional training of future teachers of philological specialties, the researcher found out the essence and content of interpersonal interaction using communication technologies, developed and implemented in the educational process of the higher school a model of "training future teachers of philological specialties for interpersonal interaction using communication technologies"; during the formation of the professional readiness of future teachers of philological

specialties, characterized the peculiarities of the application of communication technologies to interpersonal interaction.

Various innovative approaches are revealed in the process of communication interaction during the training of specialists in the higher school of L. Gusak & L. Smalko (2023) In the study of scientists, the formation of communicative competence is a prerequisite for the establishment of productive interaction during the process of communication with the subjects of activity. The relevance of the given problem is emphasized for future teachers, who will contribute to the successful professional activity of all individuals because the quality of the future professional activity of all humanity directly depends on the professional readiness of teachers and their ability to build a communicative process in school. The conducted experimental work proved that pedagogical conditions need to be developed to increase the level of communicative competence of future specialists because most modern students have an average level of communicative competence.

The specificity of the professional activity of specialists in the socionomic sphere was revealed in the studies of L. Rudenko (2018) and consists of the implementation of labor functions during professional and communicative activities, involves the influence on the subject in the process of cooperation, coordination, dialogue, direct interaction and requires a conscious penetration into the culture of the interlocutor, the ability to find constructive communication strategies, formation of communicative culture in future specialists. To form the communicative competence of future specialists, the specific principles of the formation of interpersonal interaction, which are based on general pedagogical laws, a complex of methodological approaches, and specific laws of the formation of a communicative culture, are substantiated.

The advantages of the subject-subject type of social relations are highlighted by N. Kichuk (2019) in the context of the priorities of the pedagogy of tolerance. Approaches capable of promoting interpersonal interaction in the formation of the communicative competence of a future specialist, strengthening the effective and practical character of the educational process in a higher education institution with the aim of more productive development of tolerance as a personal quality of a future specialist and the formation of professional competence in the aspects of tolerance education are characterized. Higher school education is presented as a culture-forming and culturally appropriate innovative environment. Attention is focused on such a plane of understanding the postulates of the pedagogy of tolerance and interpersonal interaction that increases the role of higher education in the multicultural education of students.

T. Ravchyna (2005) shows the features, essence, and signs of the educational environment as a means of indirect pedagogical influence on students of higher education. The directions of the organization of the educational environment in the formation of the communicative competence of the future specialist are considered, the principles of student interaction based on subject-subject interaction to develop the subject position of the individual, interpersonal interaction in the formation of the communicative competence of the future specialist and the acquisition of social, educational, professional experience.

The results of the theoretical analysis of the problem of partner interaction in the formation of communicative competence of the future specialist are presented in the study of O. Dubasenyuk (2022). It has been proven that partner interaction is necessary in the formation of the communicative competence of the future specialist, it is a pedagogical, humanistically oriented process, personal contact of the subjects of the educational process. An ideal image of the pedagogical activity, which provided for the formation in the context of communicative competence of the creative level of partnership interaction of higher school graduates, is the model of partnership interaction of masters developed by the researcher and the method of implementing such a model. The conducted research confirmed the effectiveness of the author's model implemented in the experiment.

Therefore, under the pressure of new ideas, requests, and data taking into account new approaches and means, the need for a scientific analysis of the problem of the development of the communicative competence of an individual has matured in the current conditions when society has faced an urgent need

for interpersonal interaction in the formation of the communicative competence of the future specialist, anticipatory education and professional – communicative personality development.

We set the *PURPOSE* to consider the peculiarities, directions, and ways of organizing interpersonal interaction in the formation of communicative competence of the future specialist and support of the educational environment, which is favorable in the educational process of the higher school for the development of the subject position of each individual, partnership and equal relations of teachers and students.

Methodology

A set of methods was used in the research process:

- ***Theoretical*** (analysis of psychological, pedagogical, methodological electronic and printed sources, as well as manuals and textbooks on issues of interpersonal interaction in the formation of communicative competence of the future specialist on the researched problem;
- ***Empirical*** (observation of the process of professional training of students, survey, pedagogical experiment, modeling of the educational process to generalize the learned experience of interpersonal interaction in the formation of the communicative competence of the future specialist, checking the effectiveness of the developed method of interpersonal interaction in the formation of the communicative competence of the future specialist, methods of mathematical statistics for checking the results of the experiment.

The experimental work made it possible to talk about interpersonal interaction in the formation of communicative competence of the future specialist as a serious and necessary problem that requires a holistic study in education and professional activity. The study outlines the readiness of future specialists for interpersonal interaction to form a person's communicative competence, which is both an indicator of the quality of education and the result of high-quality professional training of future specialists for interpersonal interaction, as a holistic personal sustainable education.

The stage of the experimental work of the ascertainment experiment proved that the indicators of the formation of the levels of readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist in the experimental and control groups were approximately the same, which indicates equal content and procedural characteristics of the educational process of the higher school in both groups.

The obtained data from the ascertaining stage of the research showed the necessity and importance for future specialists of modern society of developing a special method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies.

During the formative experiment, the method of forming the readiness of future specialists for interpersonal interaction during the formation of communicative competence using communication technologies was introduced into the experimental group. The control group was engaged in the usual method.

A qualitative and quantitative analysis of the results of the experiment was carried out to check the effectiveness of the method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies.

The formative experiment proved that at the end of the experimental work, the level of motivation, skills, knowledge, and reflection of interpersonal interaction was significantly higher among the students of the experimental groups.

The probability of the research results (χ2 – Pearson's test) was confirmed by the methods of mathematical statistics.

It was concluded that the developed author's method is effective, and communicative technologies (socio-semiological, discursive, narrative, information, and communication) are appropriate and correct for implementation in the process of professional training of a specialist for the implementation of interpersonal interaction in professional activities in the formation of communicative competence.

Results and Discussion

Meaningful content of interpersonal interaction, its types, main features, and role in the formation of communicative competence of the future specialist.

The category of interpersonal interaction is the basis for the formation of communicative competence of the future specialist, is considered in psychology, philosophy, pedagogy, sociology, and other humanities, and has an interdisciplinary nature. The concept of interaction is interpreted as an interdependent exchange of actions; it is universally aimed at the realization of tasks of joint activity (Bilotserkovets et al., 2022). From the point of view of psychology, in the process of interpersonal interaction, various types of psychological influence of the participants of the interaction are realized, which can be expressed in the form of communications – persuasion, infection, suggestion, and imitation (Ivaniuk et al., 2023).

There are two main types of interpersonal interaction:

1) Interaction that promotes joint activity – constructive interaction;
2) Interaction that interferes with joint activity – destructive interaction.

Within the limits of our study, the specified typology shows the activity nature of the category of interaction, interpersonal interaction in educational activity. We essentially and meaningfully connect it with communications in the process of professional training of future specialists and consider it in a communicative context.

Interpersonal interaction of future specialists of various specialties is aimed at achieving a common result, is a specific type of interaction between a student and a teacher, and aims at the formation of professional readiness of students – due to the unity of tasks, forms, methods, goals laid in the basis of communication technologies.

In the process of professional training of specialists, interpersonal interaction is a social process, as it ensures the effectiveness and flow of innovative social processes:

- The process of developing certain social skills: perceptual skills, group interaction, etc.;
- The process of socialization of the future specialist during his studies in higher education;
- The process of professional social-communicative personality development, which ensures the development of the individual personal qualities of a specialist and the development of his emotional sphere.

The content of interpersonal interaction using communication technologies depends on the personal contribution of each participant to the joint educational activity.

Let's consider the main signs of the joint activity of all participants in the educational process:

- The desire for joint activity of the participants of the educational process, which does not contradict the individual motives of the individual;
- Availability of common goals for all participants of the interaction;
- Coordination of actions in the interaction of participants in the learning process;

- Distribution of powers between the participants of the interaction;
- Realized the need for joint activity in managing the process;
- Unity of spatiotemporal functioning of participants of interpersonal interaction;
- Targeting the formed readiness for interpersonal interaction of future specialists on a single professional result.

The structure of motivation of future specialists for interpersonal interaction to form communicative competence.

In the structure of motivation of future specialists for interpersonal interaction, the following levels can be distinguished for the further formation of communicative competence:

- General professional level, which reflects the interpersonal interaction and motivation of the student for professional activity;
- The social-personal level, which reflects the motivation for interpersonal interaction to form communicative competence, which depends on the level of communication, personal characteristics of the student, his individual emotional characteristics, conflict, etc.;
- The level of specialization, which is based on the communicative interaction of the subjects of the educational process and shows the specifics of the professional activity of future specialists (Pushkar, 2016).

The basis for the formation of skills and abilities of interpersonal interaction is the motivation of future specialists, the formation of communication skills and skills of future specialists, which are manifested in:

- Skillful forecasting of the development of the communication situation;
- Ability to professional orientation in a communicative situation;
- The ability to implement a communicative plan;
- Skills in communicating through barriers;
- The ability to analyze the potential of other participants in the interaction and one's own communicative potential;
- Able to adjust emotionally to the interaction situation (Dovzhynets et al., 2023).

Communicative competence is formed from the standpoint of activity, system, competence, and personal approaches. Therefore, there are:

- A certain level of formation of professional experience of interaction with surrounding people and personal experience of interaction, one of the basic indicators of professional preparedness of a representative of a certain profession and professional competence of the "person-to-person" type (Andrievska et al., 2014).
- The ability to maintain and establish the necessary contacts with other specialists, a certain set of skills, abilities, and knowledge that ensure effective communication;
- The ability to clearly navigate the professional situation (Krylova, 2015);
- An integral quality of the individual, which performs the function of adequate functioning of the individual in society and adaptation, contains communication positions, stereotypes, attitudes, personal values, roles, etc. (Shyshko, 2015).

A common feature of almost all positions is that communicative competence is a necessary prerequisite for the effective activity of every specialist and the basis of interaction in a professional environment. At the same time, interpersonal interaction in the formation of the communicative competence of the future specialist provides opportunities for the formation of a complex of relevant knowledge and skills of the individual.

The success of communication directly depends on the specialist's communicative qualities. It is the communicative qualities of a specialist that determine the peculiarities of interaction in professional activity. The professionally important communicative qualities of a specialist include sensitivity, fairness, tolerance, sociability, tact, reflection, empathy, delicacy, the ability to make contact and listen, flexibility, eloquence, and orientation to active communication (Maksymova, 2016). Such qualities of a specialist must necessarily be reflected in the content of communicative competence since they determine the nature of the subjects of activity and their interpersonal relationships: students, colleagues, parents, and management of a higher education institution (Gusak & Smalko, 2023).

Interpersonal interaction during the formation of the communicative competence of the future specialist is personal contact with the subjects of the educational process, a humanistically oriented pedagogical process, which results in mutual positive changes in activity, behavior, relationships, qualities, and attitudes.

Interpersonal interaction in the formation of communicative competence of the future specialist is considered as cooperation when the successes of some participants in a joint activity stimulate the purposeful activity of its participants and more productive activity. The process of such interaction of the subjects of the educational process can only be a humanistically oriented pedagogical process when the participants of interpersonal interaction act as equal, parity partners to the extent of their capabilities and knowledge. The development of the natural potential of each individual, the achievement of set goals, and the realization of professional activities should be facilitated in various communicative situations by interaction with other persons (Dubasenyuk, 2022).

Interpersonal interaction is analyzed by us as a basic component of the communicative competence of future specialists because the peculiarity of interpersonal interaction is, first of all, comprehension of the situation given by the client's need. In this situation, the client and specialist combine activity, knowledge, and communication, which allows partners to come to a common opinion to influence each other for the quality of interaction. Therefore, interpersonal interaction is a property by which a specialist achieves set goals, solves professional tasks, learns and transforms himself, enters into interpersonal professional interaction, and predicts its effectiveness (Rudenko, 2018).

Leading functions and methods of training students in the aspect of forming their communicative competence.

Developed interpersonal interaction to form communicative competence is a prerequisite for the organization of productive pedagogical communication, without which professional activity is impossible.

Interpersonal interaction in the formation of communicative competence of the future specialist performs the following functions:

- Cognitive function (transfer of skills and knowledge);
- The function of social control (management of students' behavior and activities with the help of positive incentives (encouragement, praise) and negative incentives (instructions, reprimands);
- Expressive function (understanding the emotional state of another person);
- Regulatory function (influence on students to change their behavior or maintain the activity of subjects of study);
- Socialization function (benevolent attitude towards others, understanding of their interests, formation of the ability to act in the interests of the collective).

The future modern specialist must be familiar with the system of communication functions in the formation of the communicative competence of the future specialist and implement them in his professional activity, i.e., "act both as an organizer of relationships and collective activities, and as a source of information, and as a person who gets to know a group of people or another a person.

As the leading method of training students in the aspect of forming their communicative competence, we have singled out training, which, during interpersonal interaction, helps to create favorable conditions for the formation of all its indicators. The implementation of interpersonal interaction in the formation of the communicative competence of the future specialist is possible thanks to such characteristics of the training as: communicativeness, interactivity, dialogicity, the ability to activate reflection and motivation, and adjust the emotional state of the participants of the educational process.

Communication in the form of socio-psychological training has a subjective nature because training participants are equal partners, they are the ones who reveal their inner essence to each other (Mytnyk et al., 2024).

The training contributes to a mandatory focus on working with each person in the group; focusing on the development and correction of the system of personal relations; and solving a wide range of tasks related to interpersonal communication.

Various teaching methods are used in the training process, in particular:

- Interactive mini-lectures used to acquaint students with new information needed to understand current problems, where lecture messages are accompanied by active methods (exchange of ideas, conversation, brainstorming, discussion, facilitation, demonstration of presentations and video materials);
- With the help of discussions, participants openly express their positions, treat communication partners tolerantly, share their own experiences;
- Exercises and exercises relieve tension between training participants, contribute to the establishment of an open working atmosphere in the group;
- Brainstorming – method of evaluation and rapid generation of ideas;
- Clustering, a method of work and an element of other techniques (brainstorming), establish logical connections between different concepts;
- The moderation method is important for classification and creation of the same understanding of concepts, involving students in the joint solution of a certain problem;
- Facilitation helps to solve the task under the leadership of the leader (facilitator), which helps to establish conditions for effective communication, directs the work of the participants in the right direction, monitors compliance with the rules of interaction, moral norms, and activates the students' activities;
- Role-playing games can bring educational conditions as close as possible to professional conditions; therefore, the principles of interpersonal interaction are manifested in them as accurately as possible, which can strengthen the result of the educational process since the communication style, norms of behavior, communication skills formed in the game can be used in future professional activities and become a conscious part of the experience of each participant.

As an example of practical methods, various exercises provide an opportunity to develop communication skills, gain a deeper understanding of the essence of certain concepts, learn psychophysiological self-regulation, and know oneself better (Vizniuk et al., 2023).

During interpersonal interaction, while forming the communicative competence of a future specialist, students learn to express their thoughts correctly, develop the ability to verbalize thoughts and active listening, develop self-presentation skills, which encourages participants to form a positive attitude towards the chosen profession, awareness of different aspects of professional activity (Gusak & Smalko, 2023).

Modern information and communication technologies and communicative discursive technologies for interpersonal interaction in the formation of communicative competence of the future specialist.

The specificity of modern information and communication technologies is the need to use modern technology (Internet resources, personal computers, social networks, etc.) for effective interpersonal interaction of participants in the educational process in higher education. These technologies are used in two ways: as a means of communication and as a means of learning (Knysh et al., 2024).

With the help of information and communication technologies, the training of future specialists for interpersonal interaction can be carried out in the professional training of specialists thanks to the implementation of the main directions of the use of computer technology:

1) To improve the process of professional training of the future specialist – the use of modern information and communication tools as a means of education;
2) For creative development of the personality of the future specialist – the use of the specified technologies;
3) For interpersonal interaction – organization of the educational process with the help of computer equipment – outside classroom time and during classes;
4) For interpersonal interaction of students – use of modern information technologies during leisure time;
5) To intensify the management of the educational process in higher education institutions – optimization of the introduction of innovative changes into the content of the professional training of future specialists (Marushko et al., 2023).

Communicative interaction provides an opportunity in a higher education institution to introduce a future specialist into the meaningful continuum of educational space and professional activity, where future professional activity will be carried out. Narrative acts as a way of transmitting the norms of social and professional life and helps to create a linguistic environment to construct future professional activities and promote the professional self-identification of the personality of the future specialist.

Communicative discursive technologies are examples of communicative technologies that shape the interpersonal interaction of students in their professional training.

Communicative technology – discourse – takes place in the intersubjective understanding of people who belong to the space of higher education.

Pedagogical discourse, which is interesting for education and professional activity, combines pedagogical and linguistic principles of interpersonal interaction and is based on the concept of linguistic culture of participants in interpersonal interaction.

The process of forming the communicative competence of the future specialist requires the active use of dialogue as the basis of preparation for interpersonal interaction. The communicative competence of the future specialist is connected with the acquisition of respect for the interlocutor, the experience of tolerance, the ability to express one's thoughts in a way that is understandable to others, the ability to accept the opinion of another person (child), constant self-improvement in future professional activity. It is possible to effectively form, with the help of dialogic training, the entire set of the specified skills and qualities as a form of the educational process, a method, and dialogue, which is actively used in the process of professional training of future specialists (Pushkar, 2016).

The principles are necessary for interpersonal interaction in the formation of communicative competence of the future specialist.

Interpersonal interaction in the formation of the communicative competence of a future specialist is based on the fact that, unfortunately, the appropriate level of readiness of future specialists to fulfill social and

professional duties at the current stage of the development of professional education, which are realized mainly in the process of interpersonal interaction, is not ensured.

Interpersonal interaction naturally follows from the humanistic paradigm, which is its methodological foundation of modern education, which is aimed at educating a spiritually rich personality, its national consciousness, a high-level specialist, a subject of culture. Even though communicative processes are an objective phenomenon of human social reality, intensification in the 21st century requires high-quality humanistic characteristics and increased attention, especially demanded against the background of commercialization, pragmatization, mechanization, blurring of spiritual landmarks, which include humanistic, interpersonal interaction, the direction of the future specialist's communicative competence.

The conceptual principles of the formation of communicative competence of future specialists in the process of professional training in higher education are based on the theories of scientific knowledge, professional development of a person, his self-development, problem-based learning, self-actualization of the individual, didactic principles (scientific, developmental and educational nature of education, accessibility, individualization, systematicity and consistency, connection between theory and practice) and principles of professional education (fundamentalization of education, anticipatory nature of professional training, professional orientation of education, informatization, technology) (Bondarenko et al., 2023).

On this basis, the regularities of the formation of the communicative competence of the future specialist in the field of "person-to-person" are formulated:

1) The regularity of the formation of communicative competence of the future specialist through interpersonal interaction is based on the understanding of communicative culture as an individual-personal and social phenomenon, which is connected with the formation of individual and social consciousness, is its spiritual component, determined by the requirements of social development of a humanistic direction;
2) The regularity of the formation of communicative competence of the future specialist through interpersonal interaction determines the competitiveness of the future specialist and is determined in its professional and personal meanings by the level of development of communicative culture;
3) The regularity of the formation of the communicative competence of the future specialist through interpersonal interaction is that to have an effective pedagogical influence on the future specialist, the process of forming the communicative culture of students in a higher education institution is based on certain personality qualities, belongs to cognitive-transformative activity, is aimed at ensuring the self-development of the individual on a humanistic and axiological basis.
4) The regularity of the formation of the communicative competence of the future specialist through interpersonal interaction is reflected in the purposefulness of the development of the communicative culture of the future specialist as its characteristic, which is holistic, professional-personal, expressed in the unity of epistemological-cognitive, personal-reflective, professional-adaptive, operational-technological components (Koval et al., 2023).

It is with the help of such regularities that it is possible to determine the specific principles of forming the communicative competence of the future specialist through interpersonal interaction by axiological, cultural, synergistic, personally oriented, competence-based activity approaches in the process of professional training (Marrero-Sánchez & Vergara-Romero, 2023).

The principle of unity of activity and consciousness in communicative interaction declares belonging to an active and conscious subject. Activity and consciousness determine each other and are in a close relationship mediated by personality. Given this, interpersonal interaction in the formation of the communicative competence of the future specialist requires a high level of creative activity and awareness of communicative activity. When forming the communicative competence of a future specialist, the specific character of professional activity is reflected as well as the personal characteristics of the specialist in the

system of norms, values, knowledge, patterns of behavior accepted in society, the ability to naturally, organically, unforcedly realize one's skills in professional activity.

The principle of humanization and humanization on the axiological basis of professional and communicative training provides for the formation of an individual who understands his role in society should ensure, based on values, the general cultural development of the individual, the development of the ability to analyze processes and phenomena, its orientation in the world of human values that occur in social life and nature; has a high level of self-awareness, is capable of a humane attitude to the chosen profession, critical thinking, introspection, respect for the judgments of other people, to their function in the chosen professional field. The valuable nature of the communicative competence of the future specialist is expressed in the fact that humanistic values are the basis. The humanization of communication comes to the fore, the ability of the future specialist to empathize and experience the process of interpersonal interaction, sympathize and feel, distinguish good from evil, show mercy, and decency, etc.

The principle of cultural relevance of the professional formation of the individual complements and enriches the scientific nature of education, filling it with the interpersonal content of interaction. This principle means "learning in the context of culture, aimed at forming the communicative competence of the future specialist through interpersonal interaction, has an orientation of education on the values and character of culture based on its reproduction and achievements, on the inclusion of a person in the further development of socio-cultural norms. In the context of our problem, it is this principle that determines the cultural foundations of the formation of interpersonal interaction and cultural conformity in the process of professional formation of an individual, which in the current process is oriented to the priority cultural content methods and results of the educational process of a higher school. The general culture of the individual is the basis of interpersonal interaction, communicative culture, which is expressed in the style of behavior and activity in the system of social qualities and needs.

The principle of self-development of the individual in the formation of the communicative competence of the future specialist through interpersonal interaction makes it possible to interest the student in the need for self-change, who is capable of developing and constructing his activity, motivating his further development as a professional. The principle works for results and consists in the fact that future competitive specialists are highly motivated to perform work functions (needs for recognition, motives of self-respect, self-realization), successfully develop their careers, adapt faster in the professional environment, and have better psychological characteristics in terms of communicative parameters. Under such conditions, a student asserts himself as a person organizes himself, grows professionally, and develops internally.

The principle of student subjectivity in educational and professional activities consists of self-esteem, development of the student, if not as a collective subject, awareness, and recognition of the unique individuality of the student as an individual with a unique set of mental and cultural traits subject experience. This allows the individual to be constantly enriched spiritually and skillfully use subjective qualities in communication and activity, turning subjective experience into a valuable source of personal development. So, this principle in the context of forming the communicative competence of a future specialist through interpersonal interaction involves the self-realization of the individual through communication. Accordingly, interpersonal interaction contributes to the professional and personal development of a person, is a way of achieving success and self-realization in professional activity, and in the process of professional and communicative interaction, a means of self-improvement.

The principle of the integrity of a specialist's communicative functions includes the practice and theory of constructive resolution of interpersonal situations, is built based on the interpretation and analysis of professional-communicative interpersonal interaction, reflects the entire complex of tasks, the need to solve which can affect the formation of the communicative competence of the future specialist through interpersonal interaction during professional activity (Rudenko, 2018).

Directions and conditions for the organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of communicative competence of the future specialist.

Let's consider the directions of organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of communicative competence of the future specialist, ensure the unity of substructures and components relating to the integral structure of the professional training process:

- Organization of a socially and psychologically acceptable atmosphere effective for the educational activities of students;
- Provision of external favorable conditions for the subject-subject interaction of the teacher and students, the process of professional education;
- Organization of the procedure for regulating the educational process of higher education applicants;
- Organization of students' activities as the acquisition of professional experience (Shetelya et al., 2023).

First of all, it is the creation of such an atmosphere that is positively oriented toward each person, direct, open, trusting, sincere – interpersonal interaction, which provides the conditions for the development of democratic relations in higher education. To form the communicative competence of the future specialist, every moment of the organization of the educational process, interpersonal interaction should serve as a manifestation of trust, actions, sensitivity to the internal state of the student, respect for each individual, and tolerance for their thoughts and feelings.

The analyzed principles, which are necessary for interpersonal interaction in the formation of communicative competence of the future specialist, become the realities of the educational environment in higher education provided that:

- Consideration of the opinion of each participant in the educational process;
- Acceptance of each student as an individual, focusing attention on his positive aspects, the uniqueness of his culture, and individual characteristics, without degrading dignity;
- Development and manifestation of a positive attitude towards everyone;
- The use of non-verbal and verbal means to show the attitude towards the student as an individual;
- Getting rid of prejudices in interpersonal relationships;
- Positive assessment and highlighting of student achievements, faith in further success;
- Maintaining a positive sense of well-being, understanding the factors of personal behavior, identifying empathy, difficulties and striving to overcome them;
- Personal development, lack of criticism, analysis of situations, assessment of student behavior given the prospects of his future professional activity;
- Application for students in a team of various forms of cooperative learning;
- Use of dialogue, discussions, search for differences and commonalities;
- Stimulation of students' exchange of views;
- Unification of representatives of student youth in groups, various forms of collective solution of professional tasks;
- Emphasis on such values as mutual assistance, mutual respect, cooperation, and mutual support;
- Support of students' sense of belonging to a single team, assertion by the teacher of the "we" position;
- Successful work of the team and recognition of the contribution of each student to this work (Pushkar, 2016).

The experimental research.

The experimental work made it possible to talk about interpersonal interaction in the formation of communicative competence of the future specialist as a serious and necessary problem that requires a holistic study in education and professional activity. The study outlines the readiness of future specialists

for interpersonal interaction to form a person's communicative competence, which is both an indicator of the quality of education and the result of high-quality professional training of future specialists for interpersonal interaction, as a holistic personal sustainable education.

The readiness of future specialists for interpersonal interaction is:

- A prerequisite for successful interpersonal interaction of a specialist with other subjects of the educational process;
- The result of the student's professional training for interpersonal interaction, an indicator of their professional ability with the use of communication technologies;
- Through the implementation of interpersonal interaction as a type of professional activity.

The confirmatory experiment made it possible to talk about the low level of knowledge of students and the low awareness of future specialists about the problem of interpersonal interaction among students (Fig. 1):

- 65% of the surveyed respondents demonstrate an insufficient level of knowledge about the essence of interpersonal interaction in the educational and professional process, functions, principles, directions, and conditions of the organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of the communicative competence of the future specialist;
- 77% of respondents demonstrate a low level of knowledge about the possibilities of using communication technologies in the learning process,
- 72% of respondents demonstrate an insufficient level of knowledge about the structure of interpersonal interaction,
- 87% of respondents show an insufficient level of knowledge about interpersonal communication barriers,
- 75% of respondents demonstrate an insufficient level of knowledge about the principles necessary for interpersonal interaction in forming the communicative competence of a future specialist;
- 85% of respondents demonstrate imperfect knowledge about the directions and conditions of the organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of the communicative competence of the future specialist.

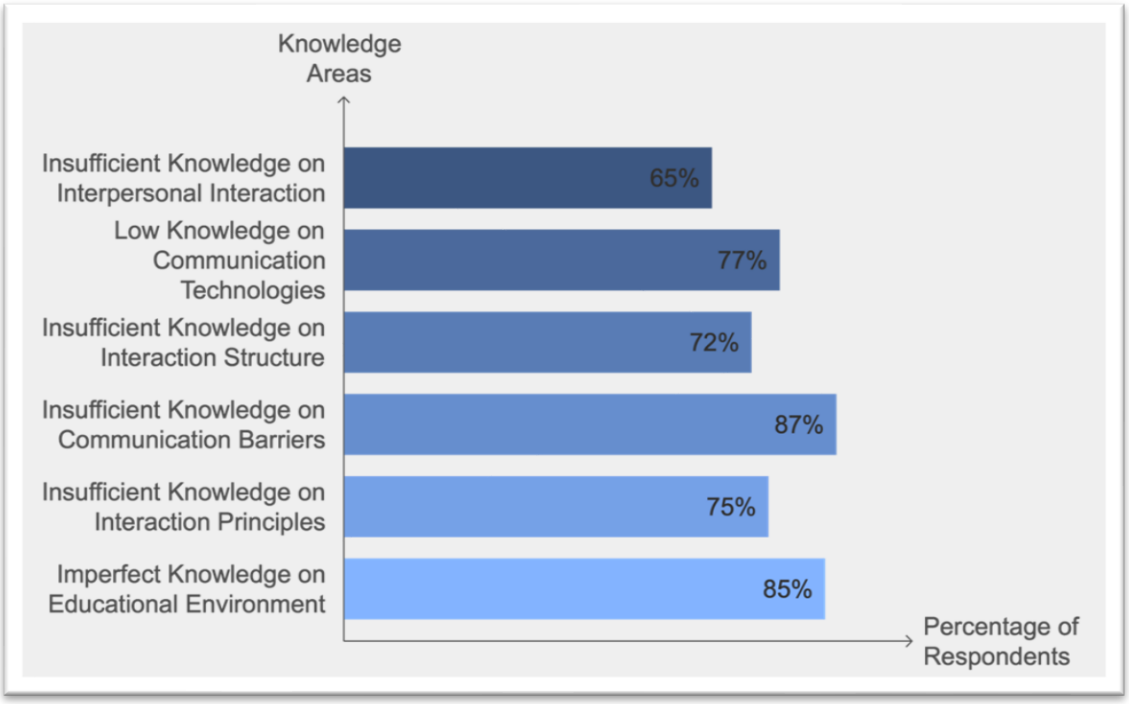

Figure 1. Students' knowledge and awareness levels on interpersonal interaction.

The empirical results of the study of the level of formation of students' skills to carry out interpersonal interaction to form communicative competence testify to the insufficient formation of the specified skills in future specialists (Fig. 2):

- 66% of respondents cannot organize joint activities with colleagues even in the learning process, do not know how to carry out interpersonal interaction to develop communicative competence;
- 70% of respondents in the process of studying subjects of the professional cycle cannot manage group dynamics;
- 70% of respondents are not able to perform adequate roles in the course of interaction inherent in professional activity;
- 66% of respondents cannot adequately use non-verbal and verbal means of communication;
- 86% of respondents do not make effective arguments regarding professional activity and do not convince the interlocutor;
- 87% of respondents during interpersonal interaction cannot evaluate and choose alternatives in the decision-making process.

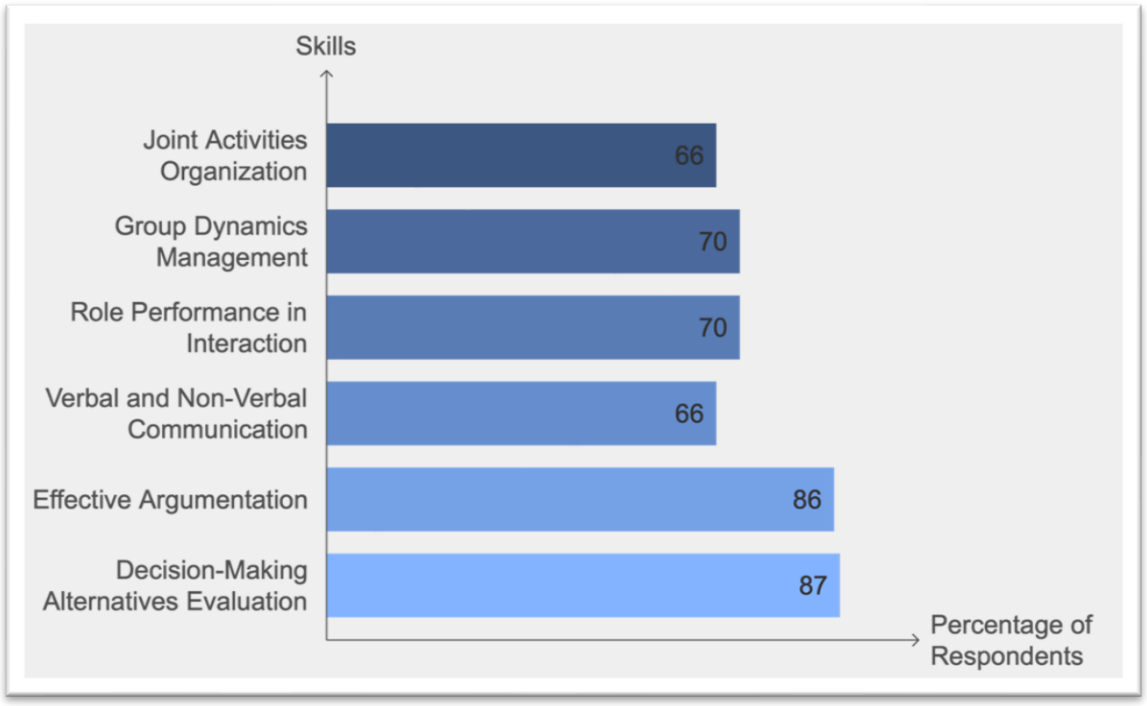

Figure 2. Deficiencies in students' interpersonal interaction skills.

According to the results of a pilot survey of the readiness of future specialists for interpersonal interaction to form the communicative competence of an individual, which is both an indicator of the quality of education and the result of high-quality professional training of future specialists for interpersonal interaction in professional activities, it was established that (Fig. 3):

- 88% of respondents in the process of interpersonal interaction do not understand the need for high results of interpersonal interaction for professional activity during self-analysis;
- 87% of respondents are not sufficiently oriented in assessing the quality of behavior of subjects of interpersonal interaction;
- 94% of respondents in the process of interpersonal interaction do not make a conscious ethical choice based on value orientations with other subjects of the educational process;
- 85% of respondents do not know how to adjust their own behavior depending on the circumstances and show a low capacity for self-regulation.

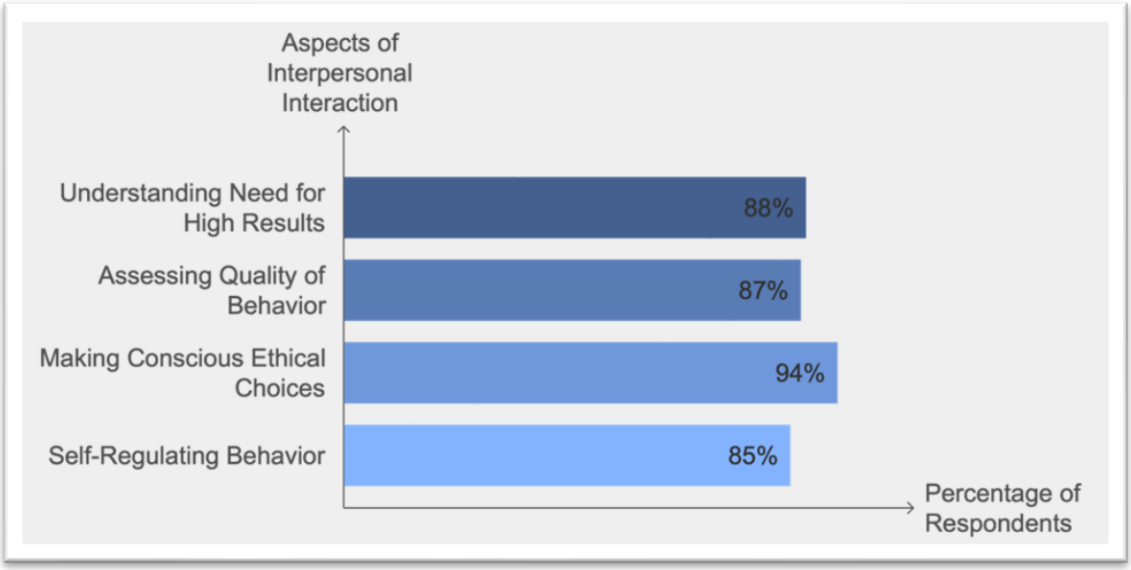

Figure 3. Readiness of future specialists for interpersonal interaction.

The stage of the experimental work of the ascertainment experiment proved that the indicators of the formation of the levels of readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist in the experimental and control groups were approximately the same, which indicates equal content and procedural characteristics of the educational process of the higher school in both groups.

The study proved that quantitative indicators of a high level of readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist range from 2% to 10%; a sufficient level of formation of the readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist – from 30% to 15%; the average level of formation of the readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist – from 29% to 34%; low level of formation – from 20% to 50%.

The predominance of a low level of formation of the readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist proved the results of the ascertainment stage of the experiment and proved the insufficiency (in terms of the operational and activity component) of the formation of students' readiness for interpersonal interaction, which indicates the insufficient formation of future specialists' skills to the implementation of effective interpersonal interaction. According to the content and operation-activity components, the lowest indicators were also obtained at a high level, which indicates a certain level of the ability to self-assess one's level and students' motivation to form the readiness of future specialists for interpersonal interaction in the formation of communicative competence of a future specialist, about a lack of skills in them and knowledge to implement interpersonal interaction.

The results of the ascertainment stage of the experiment proved that future specialists have an insufficiently formed level of interpersonal interaction. The obtained data showed the necessity and importance for the future specialists of modern society of developing a special method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies.

During the formative experiment, the method of forming the readiness of future specialists for interpersonal interaction during the formation of communicative competence using communication technologies was introduced into the experimental group. The control group was engaged in the usual method.

A qualitative and quantitative analysis of the results of the experiment was carried out to check the effectiveness of the method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies and the method of its implementation.

The formative experiment proved that at the end of the experimental work, the level of motivation, skills, knowledge, and reflection of interpersonal interaction was significantly higher among the students of the experimental groups:

- The level of motivation of students in the experimental groups almost doubled: from 9% (beginning of the experiment) to 17% (end of the experiment) for a high level of interpersonal interaction in the formation of communicative competence.
- The level of knowledge of the respondents of the experimental group about effective interpersonal interaction increased from 3% (at the beginning of the experiment) to 19% – (at the end of the experiment) to a sufficient level from 22% (beginning of the experiment) to 53% (end of the experiment).

The level of the respondents' ability to carry out effective interpersonal interaction increased significantly in the experimental group: from 2% at (the beginning of the experiment) to 10% (the end of the experiment) – a high level, and from 17% (the beginning of the experiment) to 50% (the end of the experiment) – sufficient level.

Regarding the level of formed reflection of their readiness for interpersonal interaction in the formation of communication competence of specialists, the respondents from the experimental group showed an increase in reflection – a high level from 3% to 13% during the experiment and from 24% to 51% – at a sufficient level, respectively.

Therefore, the research and experimental work and the analysis of its results proved our assumption that it is possible to form the readiness of future specialists for interpersonal interaction in the formation of communicative competence under the condition of development, theoretical substantiation, implementation in the practice of professional training of the methodology of formation of the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies.

The probability of the research results ($\chi 2$ – Pearson's test) was confirmed by the methods of mathematical statistics.

We conclude that the developed author's method is effective, and communicative technologies (socio-semiological, discursive, narrative, informational and communication) are appropriate and correct for implementation in the process of professional training of a specialist for the implementation of interpersonal interaction in the professional activity in the formation of communicative competence.

Conclusions

The content of interpersonal interaction, its types, main features, and role in the formation of communicative competence of the future specialist are clarified. The structure of motivation of future specialists for interpersonal interaction to form communicative competence is disclosed. The leading functions and methods of training students in the aspect of forming their communicative competence are highlighted. Presented are modern information and communication technologies and communicative discursive technologies for interpersonal interaction in the formation of the communicative competence of the future specialist. The principles necessary for interpersonal interaction in the formation of the communicative

competence of the future specialist are substantiated. The structure of motivation, directions, and conditions for the organization and development of the educational environment according to the principles necessary for interpersonal interaction in the formation of communicative competence of the future specialist are presented.

The experimental work made it possible to talk about interpersonal interaction in the formation of communicative competence of the future specialist as a serious and necessary problem that requires a holistic study in education and professional activity. The study outlines the readiness of future specialists for interpersonal interaction to form a person's communicative competence, which is both an indicator of the quality of education and the result of high-quality professional training of future specialists for interpersonal interaction.

The stage of the experimental work of the ascertainment experiment proved that the indicators of the formation of the levels of readiness of future specialists for interpersonal interaction in the formation of communicative competence of the future specialist in the experimental and control groups were approximately the same, which indicates equal content and procedural characteristics of the educational process of the higher school in both groups.

The obtained data from the ascertaining stage of the research showed the necessity and importance for future specialists of modern society of developing a special method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence by means of communication technologies.

During the formative experiment, the method of forming the readiness of future specialists for interpersonal interaction during the formation of communicative competence using communication technologies was introduced into the experimental group. The control group was engaged in the usual method.

A qualitative and quantitative analysis of the results of the experiment was carried out to verify the effectiveness of the method of forming the readiness of future specialists for interpersonal interaction in the formation of communicative competence using communication technologies.

The formative experiment proved that at the end of the experimental work, the level of motivation, skills, knowledge, and reflection of interpersonal interaction was significantly higher among the students of the experimental groups.

The probability of the research results ($\chi 2$ – Pearson's test) was confirmed by the methods of mathematical statistics.

It was concluded that the developed author's method is effective, and communicative technologies (socio-semiological, discursive, narrative, informational and communication) are appropriate and correct for implementation in the process of professional training of a specialist for the implementation of interpersonal interaction in professional activities in the formation of communicative competence.

Further research is needed:

- Problems of improving the practice and methodology of professional training of specialists of all specialties for interpersonal interaction in extra-auditory activities;
- The question of formation of specialists' readiness to resolve pedagogical conflicts;
- Aspects of the future specialist's development of professional competence based on effective interpersonal interaction in solving pedagogical tasks, etc.

Bibliographic references

Andrievska, V. V., Boyko, S. T., Botina, L. Y., Vynogradna, O. V., Dranishcheva, E. I., Yevchenko, I. M., ... & Tsarenko, L. G. (2014). *Methodological problems of the transformation of the communicative competence of the psychologist in the information society*: Monograph. Kyiv-Kirovohrad: Imex-LTD. https://lib.iitta.gov.ua/id/eprint/7562/2/2621_Andreevska.pdf

Bilotserkovets, M., Fomenko, T., Klochkova, T., Shcherbyna, Y., & Korniienko, L. (2022). Forming ESP oral communication skills of students by means of Zoom. *Amazonia Investiga, 11*(56), 73–81. https://doi.org/10.34069/AI/2022.56.08.8

Bondarenko, N., Cherepania, N., Malets, D., Klepar, M., & Matveieva, N. (2023). Tolerance as an important aspect of the professional competence of future specialists. *Amazonia Investiga, 12*(62), 158–167. https://doi.org/10.34069/AI/2023.62.02.14

Dovzhynets, I., Petrenko, M., Karpenko, E., Zabolotnyi, I., & Holiaka, H. (2023). Social values in musical art in the context of intercultural communication: international experience. *Amazonia Investiga, 12*(68), 151–161. https://doi.org/10.34069/AI/2023.68.08.14

Dubasenyuk, O. A. (2022). Partnership as a basic component of the communicative competence of future teachers in a master's program. *Bulletin of the Taras Shevchenko National University of Luhansk. Pedagogical Sciences, 1*(349), Part II, 17-24. http://eprints.zu.edu.ua/35602/

Gusak, L., & Smalko, L. (2023). Formation of communicative competence of future teachers. *Scientific Journal of M. P. Drahomanov National University of Science and Technology. Pedagogical Sciences: Realities and Prospects, 91*(5), 72-75. https://doi.org/10.31392/NPU-nc.series5.2023.91.15

Ivaniuk, H., Antypin, Y., Venhlovska, O., Kuzemko, L., & Savchenko, Y. (2023). Practices of psychological and pedagogical support of future teachers' personal and professional development in the conditions of distance learning. *Amazonia Investiga, 12*(67), 250–264. https://doi.org/10.34069/AI/2023.67.07.23

Kichuk, N. (2019). Subject-subject interaction as a priority of pedagogy of tolerance and personal and professional training of the future factor. *Scientific Bulletin of the Izmail State Humanitarian University. Series "Pedagogical Sciences", (42)*, 99-104. DOI: 10.31909/26168812.2019-(42)-14

Knysh, I., Drobin, A., Filimonova, T., Koycheva, T., Kushnir, A., & Kuchai, O. (2024). The use of information technologies in the educational space of Ukraine (on the example of STEAM technologies). *Revista Conrado, 20*(100), 437–448. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3979

Koval, V., Kushnir, A., Vorona, V., Balakirieva, V., Moiseienko, N., & Golubenko, N. (2023). Formation of future specialists' research competence in the process of professional training. *Amazonia Investiga, 12*(63), 77–86. https://doi.org/10.34069/AI/2023.63.03.7

Krylova, K. V. (2015). Communicative competence as a pedagogical category. Bulletin of the National Aviation University. *Series: Pedagogy, Psychology, 7*. https://doi.org/10.18372/2411-264X.7.10230

Maksymova, O. O. (2016). Communicative competence of primary school teachers. *Youth and the Market, (5)*, 59–63. http://eprints.zu.edu.ua/21881/1/3.PDF

Marrero-Sánchez, O., & Vergara-Romero, A. (2023). Digital competence of the university student. A systematic and bibliographic update. *Amazonia Investiga, 12*(67), 9–18. https://doi.org/10.34069/AI/2023.67.07.1

Marushko, L., Hura, A., Bryk, R., Baboval, N., & Karabin, O. (2023). Models of formation of professional competence of future teachers. *Amazonia Investiga, 12*(66), 314–325. https://doi.org/10.34069/AI/2023.66.06.29

Mytnyk, A., Uninets, I., Ivashkevych, E., Rashkovska, I., Ivashkevych, E., & Kuchai, O. (2024). Formation of professional competence in future psychologists using innovative technologies. *Revista Conrado, 20*(100), 293–304. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3963

Pushkar, T. M. (2016). *Formation of the readiness of future teachers of philological specialties for interpersonal interaction using communication technologies* (Doctoral dissertation). Zhytomyr Ivan Franko State University. http://eprints.zu.edu.ua/20538/1/dys_Pushkar.pdf

Ravchyna, T. (2005). Students' interaction with educational environment at higher school. *Visnyk Lviv University, 19*(2), 3–16. https://pedagogy.lnu.edu.ua/departments/pedagogika/periodic/visnyk/19_2/01_ravchyna.pdf

Rudenko, L. (2018). Principles of forming communicative culture of socionic sphere specialists. Scientific Bulletin of the Flight Academy. *Pedagogical Sciences, 3*, 158–165. https://sci.ldubgd.edu.ua/jspui/handle/123456789/4852

Shetelya, N., Oseredchuk, O., Cherkasov, V., Kravchuk, O., Yarova, L., & Kuchai, O. (2023). Competency approach in preparing professionals in an innovative educational environment in higher education. *Revista Conrado, 19*(S3), 298-307. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3512

Shyshko, A. V. (2015). Communicative competence as a component of pedagogical competence of a future foreign language teacher. Bulletin of the Dnipropetrovsk University named after Alfred Nobel. "Pedagogy and Psychology" Series. *Pedagogical Sciences, 2*(10), 245–250. http://nbuv.gov.ua/UJRN/vduep_2015_2_43

Vizniuk, I., Dolynnyi, S., Rabetska, N., Ladychenko, T., & Zagrebelna, N. (2023). Forming communicative competence in future specialists of the socio-economic sphere. *Amazonia Investiga, 12*(67), 19–29. https://doi.org/10.34069/AI/2023.67.07.2

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.6
Cómo citar:
Petrov, V., Hrechanovska, O., Shevchuk, B., Zakusylo, M., & Lekakh, A. (2024). The potential of virtual reality in modelling complex scientific processes for distance education: a scoping review. *Revista Eduweb*, *18*(4), 89-103. https://doi.org/10.46502/issn.1856-7576/2024.18.04.6

The potential of virtual reality in modelling complex scientific processes for distance education: a scoping review

El potencial de la realidad virtual en el modelado de procesos científicos complejos para la educación a distancia: una revisión del alcance

Vasyl Petrov
https://orcid.org/0000-0003-4324-7540
Petvac@ukr.net
Ph.D., in Military Sciences, Leading Research Associate at Ivan Kozhedub Kharkiv National Air Force University, Kharkiv, Ukraine.
Olena Hrechanovska
https://orcid.org/0000-0002-8342-5017
stellamondo05@gmail.com
Doctor of Pedagogical Sciences, Professor of the Department of Philosophy and Humanities of Vinnytsia National Technical University, Vinnytsia, Ukraine.
Borys Shevchuk
https://orcid.org/0000-0002-4406-1011
sh.bera04@gmail.com
Ph.D., in Pedagogical Sciences, Associate Professor, Department of Information Systems and Technologies, Faculty of Technology and Design, Ukrainian State University named after Mykhailo Drahomanov, Kyiv, Ukraine.
Mykola Zakusylo
https://orcid.org/0009-0004-9355-0980
nikola.zakusilo20071991@gmail.com
Postgraduate student, Department of Information Systems and Technologies, Faculty of Technology and Design, Ukrainian State University named after Mykhailo Drahomanov, Kyiv, Ukraine.
Albert Lekakh
https://orcid.org/0000-0003-2848-2593
super-albertlekakh@ukr.net
Ph.D., in Engineering, Head of Research Laboratory, Science Center, Ivan Kozhedub Kharkiv National Air Force University, Kharkiv, Ukraine.

Recibido: 10/10/24
Aceptado: 26/12/24

Abstract

The contemporary impact of digital technologies is evident in educational transformations, particularly in remote learning. This article aims to investigate the potential of virtual reality in modelling complex scientific processes within the distance education framework. To achieve this objective, scientific methods of comparison and synthesis were employed. The study is based on the PRISMA approach, with 74 literature sources reviewed. The findings indicate that VR is particularly relevant for higher education (in various fields such as technical, social sciences, and medicine) through the application of synchronous collaboration between different

technologies (virtual and augmented realities). Special emphasis is placed on the importance of motivation as a key component of distance learning, mainly when using VR technologies. It is suggested that the use of VR technologies holds promise, offering interactive learning environments, creating individual educational trajectories, and reducing financial costs. However, challenges include a lack of realism, socio-pedagogical issues, and the high equipment cost. The conclusions highlight that overcoming these challenges will require implementing comprehensive programmes for funding and mastering new technologies.

Keywords: interactive learning, simulation of scientific experiments, educational technologies, data visualisation.

Resumen

El impacto contemporáneo de las tecnologías digitales es evidente en las transformaciones educativas, particularmente en el aprendizaje a distancia. Este artículo tiene como objetivo investigar el potencial de la realidad virtual en el modelado de procesos científicos complejos en el marco de la educación a distancia. Para lograr este objetivo, se emplearon métodos científicos de comparación y síntesis. El estudio se basa en el enfoque PRISMA, con 74 fuentes bibliográficas revisadas. Los hallazgos indican que la realidad virtual es particularmente relevante para la educación superior (en varios campos como las ciencias técnicas, sociales y médicas) a través de la aplicación de la colaboración sincrónica entre diferentes tecnologías (realidades virtuales y aumentadas). Se hace especial hincapié en la importancia de la motivación como un componente clave del aprendizaje a distancia, principalmente cuando se utilizan tecnologías de realidad virtual. Se sugiere que el uso de tecnologías de realidad virtual es prometedor, ya que ofrece entornos de aprendizaje interactivos, crea trayectorias educativas individuales y reduce los costos financieros. Sin embargo, los desafíos incluyen la falta de realismo, problemas sociopedagógicos y el alto costo del equipo. Las conclusiones destacan que superar estos desafíos requerirá implementar programas integrales para financiar y dominar nuevas tecnologías.

Palabras clave: aprendizaje interactivo, simulación de experimentos científicos, tecnologías educativas, visualización de datos.

Introduction

Over recent decades, digital technologies have demonstrated their influence across all spheres of social life, including the field of pedagogy. Modern gadgets offer opportunities to diversify traditional learning, enriching it with new approaches and methodologies. Given the rapid development of information technologies, it is clear that education will continue to evolve towards further digitalisation. This includes transformations in distance learning, which has already gained significant popularity due to various circumstances (e.g., the COVID-19 pandemic) thanks to its features, such as broad accessibility, interactivity, and the ability to incorporate tasks of varying difficulty levels. However, one of the main challenges for the further integration of distance education into the learning process is ensuring an adequate level of practical training for students, as required by the demands of the modern labour market (Leleka et al., 2024).

This issue has attracted the attention of researchers. Summarising brief excerpts from several studies, it can be stated that virtual reality provides opportunities to create interactive environments with a wide range of possibilities for multifaceted learning (Abichandani et al., 2019; Abumalloh et al., 2021; Zhang et al., 2020b). As a result, students can fully immerse themselves in the simulation process, interact with objects in real-time, and perform certain laboratory tasks in a safe environment under the supervision of academic mentors. The availability of such interactive and visually rich tools opens up opportunities for enhancement (Yan et al., 2020; Wang et al., 2019). The use of digital technologies is driven by the fact that conducting experiments and accessing research equipment is challenging in the context of distance education (Chashechnikova et al., 2024; Potkonjak et al., 2016; Sarkar et al., 2021; Yemelyanova et al., 2022). VR technologies also enable a deeper understanding of complex scientific theories, as visualisation and the ability to actively participate in the scientific discovery process promote active learning, even in a distance format.

At the same time, researchers have emphasised the relevance of using VR in the educational process, identifying both the advantages and disadvantages of this tool (Paramita et al., 2021; Nisiotis & Kleanthous, 2019). Notably, there are strong arguments from scholars who believe that VR digital technologies offer students the potential to improve the quality of the educational process, including access to virtual laboratories or other resources that enable interactive engagement (Mozelius et al., 2020). Some even suggest that VR technologies are among the most promising, as they significantly reduce the cost of experimental processes during learning, simplifying (and automating) the work of teachers preparing tasks and lab assistants responsible for the material aspect of experiment provision (Kumar, 2024; Irwansyah et al., 2020; Herwig et al., 2018).

However, it is important to consider the opinions of researchers who analyse the students' perspectives: these studies have highlighted that virtual reality, at its current stage of technological development, differs from real-world experimental conditions, which may lead to misunderstandings of fundamental processes occurring in practice (Grunewald Nichele & do Nascimento, 2017; Gargano et al., 2018). From this perspective, it seems reasonable to agree with scholars who acknowledge the potential of VR development but note that such potential will only be realised with further improvement of education (de Moraes Rossetto et al., 2023; Cobo & Rivas, 2023; Dubiaha et al., 2022). Considering this evolution may influence key directions in the application of virtual reality technologies (Gargano et al., 2018). The integration of VR into the simulation of scientific processes and the assessment of its effectiveness remain pertinent issues.

The aim of this article is to explore the potential of virtual reality in modelling complex scientific processes within the context of distance education. Achieving this aim will require the completion of specific tasks to facilitate its realisation. These tasks include analysing relevant scientific literature, identifying the main vectors for applying VR in education, evaluating the tools, results, and outcomes of using these technologies, and examining relevant scholarly views on the prospects and challenges of employing VR technologies in distance education.

Materials and Methods

Design of the study

This study is based on a scoping review and is classified as a quantitative work. The research incorporates various materials, including academic articles, monographs, and conference proceedings. The date range spans from 2018 to 2024. This timeframe was chosen to ensure the inclusion of only current and relevant information present in contemporary academic studies.

Sample

The sample included various sources, including articles, monographs, and conference proceedings. The primary focus was on whether these works were peer-reviewed and included in reputable scientometric databases. No strict or specific geographical focus was applied; the study included research from authors across different parts of the world.

Instruments and procedure

This scoping review was conducted using a phased and systematic approach based on the PRISMA framework. The selected scientometric databases were Google Scholar and Web of Science. Key terms such as "distance education," "technologies," "virtual reality," "digital technologies," and "skills" were used in the search queries on these platforms. A total of 17,400 results were found. Initially, all duplicates were removed—8,000 in total. Articles that were unrelated to modern education and those authored by Russian scholars were excluded (-3,000). The next stage involved screening, leaving 6,400 works for further consideration. Subsequently, an analysis of the abstracts was carried out, and works unrelated to the chosen topic were discarded (-2,354). The inclusion criteria focused on the following aspects:

1. The study pertains to the implementation of virtual reality.
2. The study relates to distance education.
3. The study describes the outcomes of virtual reality implementation.
4. Language of publication: English.
5. Date range: 2018-2024, with some studies beyond this period included due to their relevance to this research.

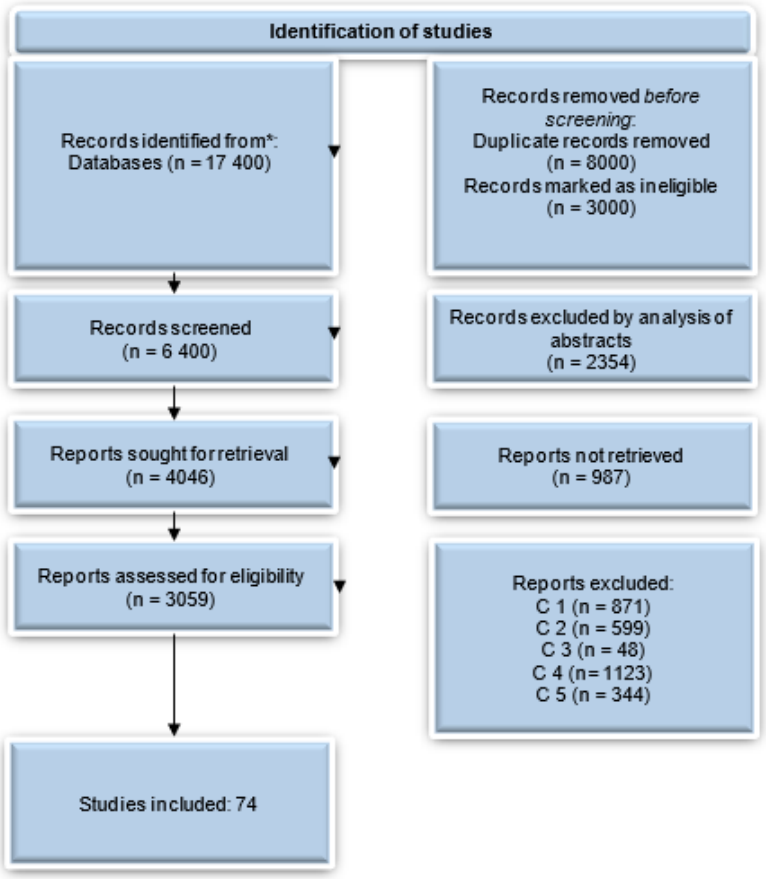

Figure 1. PRISMA-compliant data collection, identification and screening.
Source: compiled by authors.

Thus, 81 literature items were selected and subjected to analysis based on a strict selection of scientific sources.

Data analysis

Excel software was selected for data analysis. As the first indicator, elements related to forms of education were measured. Key data from the selected studies, such as the author, year of publication, mode of education, virtual reality application, type of learning, objective, and software, were entered into the first Excel table. This allowed for identifying the main directions and purposes of using this technology. The second dimension of this scoping review focused on a more detailed examination of the systems used in the selected studies. Accordingly, another table included data such as the author, year of publication, software, and system. This enabled a characterisation of the primary virtual systems utilised in modern educational institutions. A separate table was dedicated to overall measurement indicators, methods, and

research tools. Through comparative analysis, it was possible to compare the obtained data with the findings of other authors.

Results

As the first indicator, elements related to forms of education were measured. Most of the selected research studies focused on implementing VR in higher education. Although the topics of these studies were broad, the most discussed fields were technical sciences, social sciences, and medicine. Many studies also concentrated on the synchronous collaboration of different technologies, particularly virtual and augmented reality. Synchronous (collaborative) interaction was covered in 64% of the analysed studies, compared to a significantly lower 19.7% for asynchronous collaboration.

Secondary education was the primary focus of 10.8% of the articles, while the implementation of VR in primary education was highlighted in 5.0% of the studies. This is generally a low figure compared to the high percentage (62%) of articles focusing on higher education. Only 4.5% of researchers examined the features of implementing virtual reality outside formal education, such as training in workplace environments. Regarding key aspects of teaching practice, almost half of the selected articles reported that educators supported learners (55.4%). In 20.9% of cases, teachers delivered lectures and presentations as part of professional training, providing a more passive learning environment. In terms of the purpose of using virtual reality, it was primarily employed to develop practical skills, enhance cognitive abilities, support collaboration, and increase student motivation (Table 1).

Table 1.
Forms, directions, types of learning and purposes of using VR

Class and feature (N = 81)	Value (%)
Form of education	
Higher education	62%
Secondary education	10.8%
Primary education	3%
Trainings (outside formal education)	4.5%
Other form - not specified - not proven	19.7%
Directions for using VR	
Social sciences	11.5%
Technical sciences, computer sciences, robotics, engineering	12.2%
Medicine	9.5%
Mathematics and physical sciences	6%
Life sciences	4.5%
Business and management	4.5%
Education, pedagogy	26.8%
Not specified	25%
Type of education	
Synchronous	64%
Asynchronous	19.7%
Not specified, another form	16.3%
Purpose of education	
Development of practical skills	25%
Collaboration, formation of motivation	14%
Cognitive abilities	19.7%
Greater student involvement	19.7%
Not specified	21.6%

Source: compiled by authors

On a larger scale, studies have shown that virtual reality is used in various scientific fields and specialities: education and pedagogy (26.8%), computer science, robotics, ICT and informatics (12.2%), social sciences (11.5%) and medicine (9.4%) (See Figure 2).

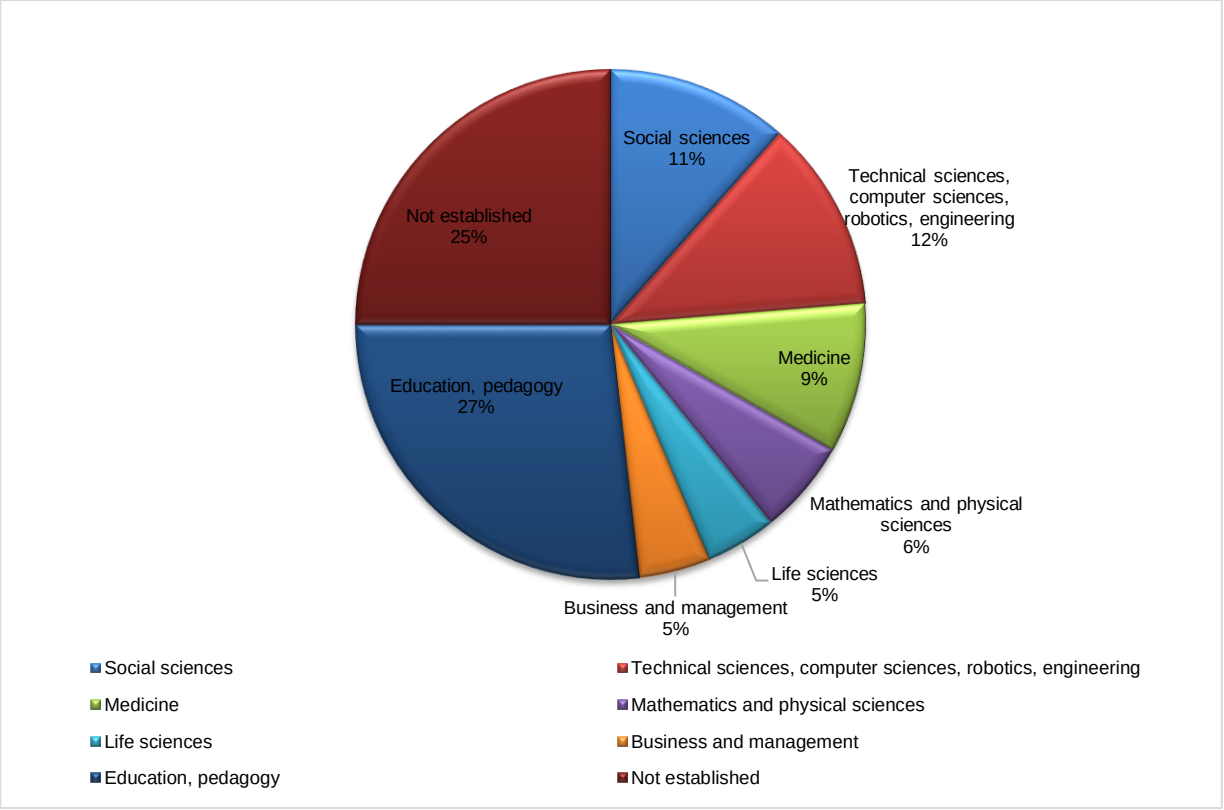

Figure 2. Main educational fields of VR use.
Source: compiled by authors

The use of virtual reality to develop practical skills is a popular direction. Also, taking into account learning objectives, the development of cognitive abilities and greater student engagement are popular areas of research.

The second dimension of this scoping review is devoted to a more detailed study of the systems used in the selected studies. In particular, attention is paid to elements related to hardware (devices, control types) and how users interact with VE (virtual embodiment, degree of virtuality). In the VRCL study, most of the research reviewed focused on monitors and displays rather than VR technologies such as HMD-based VR (HMD VR).

In contrast to the common AR/MR (35%) and HMD VR (45%), the degree of virtuality in the reviewed studies was significantly higher (80%), indicating a clear advantage of virtual simulation. To demonstrate VRCL environments, a significant proportion of the hardware used in these studies (89.2%) used flat panel monitors and screens. These studies often used desktop computer configurations with a keyboard (See Table 2).

Table 2.
Main systems, support and degree of virtuality

Class and feature (N = 81)	Value (%)
Degree of virtual	
Only HMD Virtual Reality	45%
Augmented/Mixed Reality	35%
3D Simulation (non-HMD)	20%
Hardware	
Monitor/display	35%
CAVE system	19.7%
HMDs and glasses	19.7%
Not specified	25.6%
System	
Prototype	35.6%
Application	64%
Not specified	1%

Source: compiled by authors

The virtual reality content used in digital or distance education systems varied significantly depending on the scope of each study, its objectives, and the type of learning involved. Some studies utilised theoretical knowledge acquisition methods and literature reviews (Soberanes-Martín, 2021; Bohomaz et al., 2023). However, the majority of the research employed experimental learning.

Type of research: 28% of the studies were theoretical or review-based. The remaining 72% consisted of empirical research articles. The selected empirical studies featured various target groups, with participant numbers ranging from 5 to 120. These studies predominantly involved students and educators and, in some cases, medical students and patients (in the context of medical education).

Assessment tools: Empirical studies employed various methods, including semi-structured interviews, self-assessment questionnaires, clinical tests, observation, supervision, and testing. Multiple-choice tests and other written materials were also used to assess knowledge in distance education systems. Educational initiatives were often evaluated using the Kirkpatrick model.

Focus: The selected studies primarily focused on improving student engagement and developing practical skills in virtual education. In medical education, the studies measured outcomes such as knowledge, key skills, confidence, learning effectiveness, and empathy. Table 3 presents the key metrics, including assessment tools, participants, and results.

Table 3.
Studies, metrics, tools, and outcomes of virtual reality use

Source	General indicators of measurement	Research tools	Results
Abdullah et al. (2019)	Knowledge, group work	Empirical indicators	Virtual reality greatly enhances teamwork skills
Adhikari et al. (2021)	Knowledge, practical skills, confidence	Questionnaire Semi-structured interview	Improves engagement and confidence
Andersen et al. (2021)	Knowledge, practical skills, efficiency	Testing	Improves formation of practical skills
Amini et al. (2021)	Empathy (KSA)	Testing Kirkpatrick's model	No significant difference was observed in the cognitive learning system.
Atta et al. (2022)	Practical skills, knowledge	Technical tools	Improve knowledge of space technologies
Chiang et al. (2022)	Practical skills, involvement	HMD-VR simulation, empirical indicators	Increasing self-efficacy and satisfaction with learning
Gunn et al. (2020)	Skill acquisition and confidence	Survey	Significantly improve confidence
Le & Nguyen (2020)	Acquisition of skills, formation of experience	Empirical indicators	Improve the process of acquiring skills
Mallik et al. (2021)	Confidence	Testing Kirkpatrick's model E-survey	The level of confidence has increased
Giordano et al. (2020)	Knowledge, experience, feeling	Survey	There is no noticeable difference compared to the post-test
Pérez et al. (2022)	Development of social skills	Qualitative, phenomenological study	Significant improvement in social skills
Hood et al. (2021)	Educational management process with the help of VR	Pilot study	Workflow optimisation in clinical settings
Osmanlliu et al. (2020)	Providing comfort	Pilot pragmatic randomised controlled trial	Improvement of comfort, acquisition of practical skills
Liu (2020)	Establishing empathy	vOSviewer Clustering and data visualisation	VR has provided a spectrum of latitude to establish empathy
Chaiyarak et al. (2021)	Knowledge, practical skills	Empirical indicators	Development of knowledge, skills, improvement of student engagement
Aebersold et al. (2018)	Interactivity, practical skills	Mixed study Survey Interview	Improvement of integrability
Bedregal-Alpaca et al. (2020)	Skills, theory	Theoretical study	Improving student engagement
Dhar et al. (2023)	Knowledge, skills, theory, confidence, experience	Scoping-review	Improving student engagement, experience and skills
Anthony Jnr & Noel. (2021)	Knowledge, skills	Assessment	Development of knowledge, skills, improvement of student engagement
Ergüzen et al. (2021)	Improvement of technological indicators	Experiment Survey	Improvement of technological infrastructure
Zhang et al. (2020a)	Quality, experience, and involvement of students	Survey	Improving students' abilities

Source: compiled by authors

Considering the results of virtual reality implementation, contemporary researchers note more positive aspects than negative ones. Based on the conducted analysis, existing challenges, as well as the prospects and difficulties of using VR technology in distance learning, have been identified (Table 4). It is important to highlight that this current understanding is formed from the examination of existing academic viewpoints, which does not preclude the possibility that new phenomena and technologies may emerge, leading to the revision, adjustment, or even rejection of the currently available perspectives.

Table 4.
Prospects and Challenges of Using Virtual Reality (VR)

Prospects	Difficulties
Creation of Interactive Environments. VR technologies provide opportunities for interactive engagement with complex scientific phenomena and processes in real time. This enables exploring processes that are difficult to replicate in standard conditions (Hubal, 2012; Rasulov, 2024).	Limitations of Realism in Conducting Classes. It is challenging to model certain physical phenomena that are directly influenced by external environmental conditions, such as temperature, gravitational force, and atmospheric pressure.
Personalisation. VR technologies are adaptable to creating personalised learning environments that cater to each student's needs. This versatility also allows for the effective integration of multiple disciplines.	Pedagogical and Social Challenges. The application of VR technologies necessitates updating pedagogical methodologies, as most contemporary knowledge is oriented towards traditional education models.
Reduction of Financial Costs and Increased Motivation. The use of VR technologies reduces financial costs related to equipment and materials. Simulations eliminate the need for physical materials (Atta et al., 2022; Dhar et al., 2023).	High Costs and Requirements. These technologies are costly. In addition to the expense of hardware, the software and the creation of educational content also require significant investment.

Source: compiled by authors

The prospects for applying VR technologies to modelling complex scientific processes for distance education are promising. Such digital technologies enhance pedagogical capabilities, promote innovative approaches in education, and offer several advantages over traditional teaching methods. However, overcoming the associated challenges will require significant investments in technical infrastructure, updated pedagogical methodologies, and increased digital literacy levels among learners and educators.

Discussion

This article aimed to analyse the potential of virtual reality (VR) in modelling complex scientific processes within the context of distance education. Accordingly, the findings indicate that most selected research studies focused on using VR in higher education, particularly in technical sciences, social sciences, and medicine. It was established that most researchers examined synchronous collaboration among various technologies (including virtual and augmented realities) instead of asynchronous collaboration. The utilisation of VR in distance education within secondary education was represented in 10.8% of publications, while its application in primary education accounted for only 5.0% of the works. Furthermore, only 4.5% of researchers investigated the implementation of virtual reality beyond formal education. The data obtained affirm the trend of understanding VR technologies primarily as opportunities for academic development in a university environment, a perspective highlighted by Al-Ansi et al. (2023) and Antonioli et al. (2014). One may concur, for example, with the conclusions of Austin (2023) and Ikwuka et al. (2024) that the scientific component in secondary schools, even within STEM education, lags behind that of universities. This opinion evidently reflects current trends in pedagogical and scientific advancement in distance education, whereby higher VR technologies are primarily suited for advanced levels of education. Additionally, the results indicate that among the elements related to hardware (devices, types of control) and user interaction with virtual environments (VE), researchers emphasised monitors and displays rather than VR technologies such as head-mounted displays (HMD VR). The use of VR systems for training or therapeutic purposes was less prevalent than for educational objectives (skill formation), which accounted for approximately 25% of the studies. The majority of research concerning the implementation of virtual reality primarily centred on providing virtual environments with various cognitive tasks. Notably, only 28% of the analysed works were theoretical, review, or systematic studies; the remaining 72% consisted of empirical research materials. This aligns with other scholars' conclusions that the results of using virtual reality in distance education should undergo empirical rather than theoretical validation (Aydogan & Aras, 2019; Bingham, 2024; Boichenko et al., 2023; Cejas Martínez et al., 2021). Specifically, the use of structured and semi-structured interviews, surveys, and questionnaires to assess programmes, conduct tests, and perform observations, among other measures, serves as relevant indicators of the effectiveness of distance education employing VR (Ma'ruf et al., 2024).

The results reveal that contemporary research focuses on improving student engagement and developing practical skills within virtual education systems. The motivation of students is also emphasised in scientific studies that discuss the importance of ensuring this metric during the implementation of distance education (Wolf et al., 2020; van der Meer et al., 2023; Smith et al., 2022). However, other scholars have identified that the significance of motivation may be overestimated, as numerous additional challenges can hinder distance learning (Cheng et al., 2021; Cortiz & Silva, 2017; Kljun et al., 2020). Furthermore, the use of VR holds considerable promise in engaging students who are interested in establishing such learning environments. It may be necessary to reassess the motivation of educators, a relatively underexplored issue, given that they bear additional burdens associated with using VR.

The study's proposed results indicate that utilising VR technology holds significant promise. Specifically, these digital solutions enhance the interactivity of learning environments, facilitate personalised education, and enable interdisciplinary studies. They also contribute to reducing financial expenditures on laboratory equipment and reagents while increasing students' engagement in the learning process. The findings corroborate the conclusions of other scholars regarding the vast potential for further integration of AR/VR technologies into the educational process based on distance learning (Daling et al., 2020; de Back et al., 2020; Makhkamova et al., 2020). Some researchers also emphasise that virtual laboratories allow for safe experimentation, particularly when dealing with tasks in atomic physics, medicine, art, chemistry, or when interacting with other hazardous substances (Campisi et al., 2020; Cole et al., 2018; Lichty, 2020). This discussion is valuable from a philosophical standpoint, as it highlights the potential negative psychological effects that digitalisation may have when performing practical tasks.

The challenges associated with the application of virtual reality have also been noted. Such findings align with the conclusions of researchers who recognise existing issues in the development of distance education and propose various solutions for creating comprehensive programmes for the advancement of VR environments (Haleem et al., 2022; Harb, 2019; Hrechanyk et al., 2023). For instance, the cost issue can also be viewed from a different perspective: virtual learning environments allow students from various countries to study without the need for travel to a single location, meaning that some costs that educational institutions would have incurred for purchasing equipment and updating software will automatically shift to the students (Santoveña-Casal & Fernández Pérez, 2020).

At the same time, researchers raise pertinent observations regarding the difficulty of adapting VR to various academic disciplines—the possibility of creating universal software currently does not exist, and developing specialised programmes can be quite costly (Nazarenko, 2015; Malchenko et al., 2020; Raghaw et al., 2018). The lack of standardisation also complicates the overcoming of challenges in using VR in distance education, leading not only to the fragmentation of the educational services market but potentially harming students' health, as emphasised by Liu (2020), Malchenko et al. (2021), and Mladenovic (2020). Clearly, addressing such challenges will require comprehensive solutions and the formulation of holistic strategies. The methodology proposed in the study has certain limitations that warrant attention. Firstly, this pertains to the scholarly literature included in the research. Only English-language publications from peer-reviewed journals or monographic studies published in international journals with the involvement of reviewers were utilised. While this approach allowed for the selection of specialised studies, some non-English publications may have been overlooked. Moreover, despite the positive aspects of this approach, there is a downside: studies published earlier may have been neglected. Such observations do not cast doubt on the relevance of the obtained results but rather open avenues for further analysis of this issue.

Conclusions

The current stage of digitalisation in society has transformed all spheres of life, including education, which is increasingly conducted in a distance format using modern digital solutions, particularly VR technologies. As a result of the conducted analysis, it has been established that researchers primarily focus on the use of VR within higher education systems (across various fields such as technical sciences, social sciences, and medicine) through the lens of synchronous collaboration of different technologies (virtual and augmented reality).

The findings confirm the trend of understanding VR technologies mainly as opportunities for scientific development within the university environment. Among the elements related to hardware (devices, control types) and the ways users interact with virtual environments (VE) (virtual embodiment, degree of virtuality), researchers have emphasised monitors and displays rather than VR technologies such as head-mounted displays (HMD VR).

Certain challenges exist—namely, limitations on the realism of conducting classes, pedagogical and social challenges, and the high costs of equipment and the requirements for its updating. Overcoming these challenges will require comprehensive programmes integrating distance learning with related technologies (including VR).

Promising directions for further research include analysing teachers' motivation when working with VR technologies. Available information indicates the popularity of empirical studies among students. While this approach is entirely valid, it is also important to consider the perspectives on these technologies provided by educators to account for the multifaceted nature of distance learning.

Bibliographic references

Abichandani, P., Mcintyre, W., Fligor, W., & Lobo, D. (2019). Solar energy education through a cloud-based desktop virtual reality system. *IEEE Access*, *7*, 147081– 147093. https://doi.org/10.1109/access.2019.2945700

Abumalloh, R. A., Asadi, S., Nilashi, M., Minaei-Bidgoli, B., Nayer, F. K., Samad, S., Mohd, S., & Ibrahim, O. (2021). The impact of coronavirus pandemic (COVID-19) on education: The role of virtual and remote laboratories in education. *Technology in Society*, *67*, 101728. https://doi.org/10.1016/j.techsoc.2021.101728

Abdullah, J., Mohd-Isa, W. N., & Samsudin, M. A. (2019). Virtual reality to improve group work skill and self-directed learning in problem-based learning narratives. *Virtual Reality*, *23*(4), 461–471. https://doi.org/10.1007/s10055-019-00381-1

Adhikari, R., Kydonaki, C., Lawrie, J., O'Reilly, M., Ballantyne, B., Whitehorn, J., & Paterson, R. (2021). A mixed-methods feasibility study to assess the acceptability and applicability of immersive virtual reality sepsis game as an adjunct to nursing education. *Nurse Education Today*, *103*, 104944. https://doi.org/10.1016/j.nedt.2021.104944

Aebersold, M., Voepel-Lewis, T., Cherara, L., Weber, M., Khouri, C., Levine, R., & Tait, A. R. (2018). Interactive Anatomy-Augmented Virtual Simulation Training. *Clinical Simulation in Nursing*, *15*, 34–41. https://doi.org/10.1016/j.ecns.2017.09.008

Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Social Sciences & Humanities Open*, *8*(1), 100532. https://doi.org/10.1016/j.ssaho.2023.100532

Amini, H., Gregory, M. E., Abrams, M. A., Luna, J., Roland, M., Sova, L. N., Bean, C., Huang, Y., Pfeil, S. A., Townsend, J., & Lin, E. D. (2021). Feasibility and usability study of a pilot immersive virtual reality-based empathy training for dental providers. *Journal of Dental Education*, *85*(6), 856–865. https://doi.org/10.1002/jdd.12566

Andersen, N. L., Jensen, R. O., Posth, S., Laursen, C. B., Jørgensen, R., & Graumann, O. (2021). Teaching ultrasound-guided peripheral venous catheter placement through immersive virtual reality. *Medicine*, *100*(27), Article e26394. https://doi.org/10.1097/md.0000000000026394

Antonioli, M., Blake, C., & Sparks, K. (2014). Augmented reality applications in education. *The Journal of Technology Studies*, *40*(2), 96–107. https://doi.org/10.21061/jots.v40i2.a.4

Anthony, Jnr, B., & Noel, S. (2021). Examining the adoption of emergency remote teaching and virtual learning during and after the COVID-19 pandemic. *International Journal of Educational Management*, *35*(6), 1136-1150. https://doi.org/10.1108/ijem-08-2020-0370

Atta, G., Abdelsattar, A., Elfiky, D., Zahran, M., Farag, M., & Slim, S. O. (2022). Virtual reality in space technology education. *Education Sciences*, *12*(12), 890. https://doi.org/10.3390/educsci12120890

Austin, E. E. H. (2023). Virtual Reality. In *Going Global in the World Language Classroom* (pp. 143–146). Routledge. https://doi.org/10.4324/9781003384267-24

Aydogan, H., & Aras, F. (2019). Design, simulation and virtual implementation of a novel fundamental programmable logic controllers laboratory in a 3D virtual world. *The International Journal of Electrical Engineering & Education*, *59*(3), 266-281. https://doi.org/10.1177/0020720919856249

Bedregal-Alpaca, N., Sharhorodska, O., Jiménez-Gonzáles, L., & Arce-Apaza, R. (2020). A gamification experience and virtual reality in teaching astronomy in basic education. *International Journal of Advanced Computer Science and Applications*, *11*(5). https://doi.org/10.14569/ijacsa.2020.0110566

Bingham, C. (2024). Education and Artificial Intelligence at the Scene of Writing: A Derridean Consideration. *Futurity Philosophy, 3*(4), 34–46. https://doi.org/10.57125/FP.2024.12.30.03

Bohomaz, O., Koreneva, I., Lihus, V., Kambalova, Y., Shevchuk, V., & Tolchieva, H. (2023). Regarding The Development of Educational and Scientific Potential in the 21st Century. *Conhecimento & Diversidade*, *15*(38), 479–495. https://doi.org/10.18316/rcd.v15i38.11100

Boichenko, M., Churychkanych, I., Kulichenko, A., Shramko, R., & Rakhno, M. (2023). Mind maps to boost the learning of English as L2 at higher education institutions in Ukraine. *Amazonia Investiga*, *12*(70), 229–240. https://doi.org/10.34069/ai/2023.70.10.21

Bosa, V., Marieiev, D., Balalaieva, O., Krokhmal, A., & Solovei, A. (2024). Implementation of virtual reality in foreign language teaching. *Amazonia Investiga*, *13*(73), 187–199. https://doi.org/10.34069/AI/2024.73.01.15

Cejas Martínez, M. F., Navarro Cejas, M., Venegas Alvarez, G. S., Proaño Rodríguez, C. E., & Mendoza Velazco, D. J. (2021). Student perceptions of ecuadorian virtual platforms during the covid-19 pandemic. *Problems of Education in the 21st Century*, *79*(2), 241–254. https://doi.org/10.33225/pec/21.79.241

Campisi, C. A., Li, E. H., Jimenez, D. E., & Milanaik, R. L. (2020). Augmented reality in medical education and training: From physicians to patients. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 111–138). Springer. https://doi.org/10.1007/978-3-030-42156-4_7

Chaiyarak, S., Nilsook, P., & Wannapiroon, P. (2021). An empirical study of intelligent virtual universal learning platforms. In *2021 research, invention, and innovation congress: Innovation electricals and electronics (RI2C)*. IEEE. https://doi.org/10.1109/ri2c51727.2021.9559785

Chashechnikova, O., Odintsova, O., Hordiienko, I., Danylchuk, O., & Popova, L. (2024). Innovative technologies for the development of critical thinking in students. *Amazonia Investiga, 13*(81), 197–213. https://doi.org/10.34069/AI/2024.81.09.16

Cheng, L., Niu, W.-C., Zhao, X.-G., Xu, C.-L., & Hou, Z.-Y. (2021). Design and implementation of college physics teaching platform based on virtual experiment scene. *The International Journal of Electrical Engineering & Education*, 002072092098468. https://doi.org/10.1177/0020720920984688

Chiang, D.-H., Huang, C.-C., Cheng, S.-C., Cheng, J.-C., Wu, C.-H., Huang, S.-S., Yang, Y.-Y., Yang, L.-Y., Kao, S.-Y., Chen, C.-H., Shulruf, B., & Lee, F.-Y. (2022). Immersive virtual reality (VR) training increases the self-efficacy of in-hospital healthcare providers and patient families regarding tracheostomy-related knowledge and care skills. *Medicine*, *101*(2), Article e28570. https://doi.org/10.1097/md.0000000000028570

Cobo, C., & Rivas, A. (2023). *The new digital education policy landscape: From education systems to platforms*. Taylor & Francis.

Cole, M., Cohen, C., Wilhelm, J., & Lindell, R. (2018). Spatial thinking in astronomy education research. *Physical Review Physics Education Research*, *14*(1). https://doi.org/10.1103/physrevphyseducres.14.010139

Cortiz, D., & Silva, J. O. (2017). Web and virtual reality as platforms to improve online education experiences. In *2017 10th international conference on human system interactions (HSI)*. IEEE. https://doi.org/10.1109/hsi.2017.8005003

Daling, L., Kommetter, C., Abdelrazeq, A., Ebner, M., & Ebner, M. (2020). Mixed reality books: Applying augmented and virtual reality in mining engineering education. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 185–195). Springer. https://doi.org/10.1007/978-3-030-42156-4_10

de Back, T. T., Tinga, A. M., Nguyen, P., & Louwerse, M. M. (2020). Benefits of immersive collaborative learning in CAVE-based virtual reality. *International Journal of Educational Technology in Higher Education*, *17*(1). https://doi.org/10.1186/s41239-020-00228-9

de Moraes Rossetto, A. G., Martins, T. C., Silva, L. A., Leithardt, D. R. F., Bermejo-Gil, B. M., & Leithardt, V. R. Q. (2023). An analysis of the use of augmented reality and virtual reality as educational resources. *Computer Applications in Engineering Education*. https://doi.org/10.1002/cae.22671

Dubiaha S., Huz V., Shevchenko Yu., Fedorenko S., & Kolomiiets Yu. (2022). Formation of speech regulation of educational activity in junior schoolchildren with speech disorders. *AD ALTA: Journal of Interdisciplinary Research*. *13*(XXXV), 88-95. http://eprints.mdpu.org.ua/id/eprint/12944/1/стаття_2023.pdf

Dhar, E., Upadhyay, U., Huang, Y., Uddin, M., Manias, G., Kyriazis, D., Wajid, U., AlShawaf, H., & Syed Abdul, S. (2023). A scoping review to assess the effects of virtual reality in medical education and clinical care. *DIGITAL HEALTH*, *9*, 205520762311580. https://doi.org/10.1177/20552076231158022

Ergüzen, A., Erdal, E., Ünver, M., & Özcan, A. (2021). Improving technological infrastructure of distance education through trustworthy platform-independent virtual software application pools. *Applied Sciences*, *11*(3), 1214. https://doi.org/10.3390/app11031214

Gargano, M., Gasperini, A., Schiavone, L., & Brunetti, F. (2018). Polvere di stelle The Italian platform for data-sharing and data-preserving of modern and ancient astronomical resources. *EPJ Web of Conferences*, *186*, 07002. https://doi.org/10.1051/epjconf/201818607002

Giordano, N. A., Whitney, C. E., Axson, S. A., Cassidy, K., Rosado, E., & Hoyt-Brennan, A. M. (2020). A pilot study to compare virtual reality to hybrid simulation for opioid-related overdose and naloxone training. *Nurse Education Today*, *88*, 104365. https://doi.org/10.1016/j.nedt.2020.104365

Gunn, T., Rowntree, P., Starkey, D., & Nissen, L. (2020). The use of virtual reality computed tomography simulation within a medical imaging and a radiation therapy undergraduate programme. *Journal of Medical Radiation Sciences, 68*(1), 28-36. https://doi.org/10.1002/jmrs.436

Grunewald Nichele, A., & do Nascimento, G. (2017). Augmented reality in teaching chemistry. In *INTED2017 proceedings* (pp. 8736–8743). IATED. https://doi.org/10.21125/inted.2017.2069

Haleem, P. A., Javaid, D. M., Qadri, P. M. A., & Suman, D. R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*, 275-285. https://doi.org/10.1016/j.susoc.2022.05.004

Harb, G. (2019). Reshaping undergraduates research experience with station rotation learning model. *International Journal of Advanced Research*, *7*(11), 702–710. https://doi.org/10.21474/ijar01/10061

Herwig, F., Andrassy, R., Annau, N., Clarkson, O., Côté, B., D'Sa, A., Jones, S., Moa, B., O'Connell, J., Porter, D., Ritter, C., & Woodward, P. (2018). Cyberhubs: Virtual research environments for astronomy. *The Astrophysical Journal Supplement Series*, *236*(1), 2. https://doi.org/10.3847/1538-4365/aab777

Hrechanyk, N., Koval, D., Kovalchuk, I., Slovik, O., & Zinchenko, L. (2023). Exploring benefits and models of blended learning technology in modern professional training. *Amazonia Investiga*, *12*(67), 54–65. https://doi.org/10.34069/ai/2023.67.07.5

Hood, R. J., Maltby, S., Keynes, A., Kluge, M. G., Nalivaiko, E., Ryan, A., Cox, M., Parsons, M. W., Paul, C. L., Garcia-Esperon, C., Spratt, N. J., Levi, C. R., & Walker, F. R. (2021). Development and Pilot Implementation of TACTICS VR: A Virtual Reality-Based Stroke Management Workflow Training Application and Training Framework. *Frontiers in Neurology*, *12*. https://doi.org/10.3389/fneur.2021.665808

Hubal, H. M. (2012). The generalized kinetic equation for symmetric particle systems. *Mathematica Scandinavica*, *110*(1), 140. https://doi.org/10.7146/math.scand.a-15201

Ikwuka, O. I., Eleje, L. I., Iheanacho, E. C., & Onyebuchi, A. C. (2024). Teacher's Attitude towards the Use of Digital Technologies for Capturing Students' Data in Secondary Schools in Imo State, Nigeria. *Futurity of Social Sciences, 2*(4), 39–59. https://doi.org/10.57125/fs.2024.12.20.03

Irwansyah, F. S., Nur Asyiah, E., Maylawati, D. S., Farida, I., & Ramdhani, M. A. (2020). The development of augmented reality applications for chemistry learning. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 159–183). Springer. https://doi.org/10.1007/978-3-030-42156-4_9

Kljun, M., Geroimenko, V., & Čopič Pucihar, K. (2020). Augmented reality in education: Current status and advancement of the field. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 3–21). Springer. https://doi.org/10.1007/978-3-030-42156-4_1

Kumar, N. (2024). Innovative Approaches of E-Learning in College Education: Global Experience. *E-Learning Innovations Journal, 2*(2), 36–51. https://doi.org/10.57125/ELIJ.2024.09.25.03

Le, H., & Nguyen, M. (2020). An online platform for enhancing learning experiences with web-based augmented reality and pictorial bar code. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 45–57). Springer. https://doi.org/10.1007/978-3-030-42156-4_3

Leleka, V., Ketsyk-Zinchenko, U., Petrenko, N., Potapchuk, N., & Syroiezhko, O. (2024). Innovative technologies for healthy education: A practical guide for educational institutions. *Amazonia Investiga, 13*(81), 214–233. https://doi.org/10.34069/AI/2024.81.09.17

Lichty, P. (2020). Making inside the augment: Augmented reality and art/design education. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 261–278). Springer. https://doi.org/10.1007/978-3-030-42156-4_15

Liu, Y. (2020). The application of virtual reality in empathy establishment: Foresee the future. In *2020 5th International Conference on Computational Intelligence and Applications (ICCIA)*. IEEE. https://doi.org/10.1109/iccia49625.2020.00043

Makhkamova, A., Exner, J.-P., Greff, T., & Werth, D. (2020). Towards a Taxonomy of Virtual Reality Usage in Education: A Systematic Review. In *Augmented Reality and Virtual Reality* (pp. 283–296). Springer International Publishing. https://doi.org/10.1007/978-3-030-37869-1_23

Mallik, R., Patel, M., Atkinson, B., & Kar, P. (2021). Exploring the Role of Virtual Reality to Support Clinical Diabetes Training—A Pilot Study. *Journal of Diabetes Science and Technology*, *16*(4), 844-851. https://doi.org/10.1177/19322968211027847

Malchenko, S. L., Mykoliuk, D. V., & Kiv, A. E. (2020). Using interactive technologies to study the evolution of stars in astronomy classes. In A. E. Kiv & M. P. Shyshkina (Eds.), *Augmented Reality in Education: Proceedings of the 2nd International Workshop on Augmented Reality in Education* (pp. 145-155). CEUR Workshop Proceedings. https://doi.org/10.31812/123456789/3752

Malchenko, S. L., Tsarynnyk, M. S., Poliarenko, V. S., Berezovska-Savchuk, N. A., & Liu, S. (2021). Mobile technologies providing educational activity during classes. *Journal of Physics: Conference Series*, *1946*(1), 012010. https://doi.org/10.1088/1742-6596/1946/1/012010

Mladenovic, R. (2020). The usage of augmented reality in dental education. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 139–157). Springer. https://doi.org/10.1007/978-3-030-42156-4_8

Mozelius, P., Jaldemark, J., Eriksson Bergström, S., & Sundgren, M. (2020). The concept of 'Bringing your own device' in scaffolded and augmented education. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 59–70). Springer. https://doi.org/10.1007/978-3-030-42156-4_4

Ma'ruf, M. R., Anggeria, E., Siregar, R. F., Sinaga, E. S., Aminah, Rahmi, I. M., Siregar, P. S., & Kaban, F. B. (2024). Application of Swedish Massage Therapy for Lower Extremities to Alleviate Muscle Cramps in Chronic Kidney Disease Patients. *Futurity Medicine, 3*(4). https://doi.org/10.57125/fem.2024.12.30.01

Nazarenko, A. L. (2015). Blended learning vs traditional learning: What works? (A case study research). *Procedia – Social and Behavioral Sciences*, *200*, 77–82. https://doi.org/10.1016/j.sbspro.2015.08.018

Nisiotis, L., & Kleanthous, S. (2019). The Relationship Between Students' Engagement and the Development of Transactive Memory Systems in MUVE. In *ITiCSE '19: Innovation and Technology in Computer Science Education*. ACM. https://doi.org/10.1145/3304221.3319743

Osmanlliu, E., Trottier, E. D., Bailey, B., Lagacé, M., Certain, M., Khadra, C., ... & Le May, S. (2020). Distraction in the Emergency department using Virtual reality for INtravenous procedures in Children to Improve comfort (DEVINCI): a pilot pragmatic randomized controlled trial. *Canadian Journal of Emergency Medicine*, *23*, 94–102. https://doi.org/10.1007/s43678-020-00006-6

Paramita, A., Yulia, C., & Nikmawati, E. E. (2021). Augmented reality in nutrition education. *IOP Conference Series: Materials Science and Engineering*, *1098*, Article 022108. https://doi.org/10.1088/1757-899x/1098/2/022108

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanović, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education*, *95*, 309–327. https://doi.org/10.1016/j.compedu.2016.02.002

Pérez, F. E. L., Montero, J. M. C., Meléndez, L. V., & Reynosa Navarro, E. (2022). Development of social skills of high school students on virtual platforms, 2021. *World Journal on Educational Technology: Current Issues*, *14*(1), 231–242. https://doi.org/10.18844/wjet.v14i1.6720

Raghaw, M., Paulose, J., & Goswami, B. (2018). Augmented reality for history education. *International Journal of Engineering & Technology*, *7*(2.6), 121–125. Doi: 10.14419/ijet.v7i2.6.10136

Rasulov, R. (2024). Economic Substantiation of Innovative Solutions for Direct Cooperation between Manufacturers and Restaurants. *Futurity Economics & Law, 4*(4), 121–136. https://doi.org/10.57125/FEL.2024.12.25.07

Santoveña-Casal, S., & Fernández Pérez, M. D. (2020). Sustainable distance education: Comparison of digital pedagogical models. *Sustainability*, *12*(21), Article 9067. https://doi.org/10.3390/su12219067

Sarkar, B., Saha, D., & Das, A. (2021). Voice of the future classroom: Virtual and augmented reality. In *Digital education for the 21st century* (p. 181–206). Apple Academic Press. https://doi.org/10.1201/9781003180517-8

Soberanes-Martín, A. (2021). Augmented reality: An educational resource for the nursing graduate. In I. Management Association (Ed.), *Research anthology on nursing education and overcoming challenges in the workplace* (pp. 150–170). IGI Global. https://doi.org/10.4018/978-1-7998-9161-1.ch010

Smith, J. R., Snapp, B., Madar, S., Brown, J. R., Fowler, J., Andersen, M., Porter, C. D., & Orban, C. (2022). A smartphone-based virtual reality plotting system for STEM education. *Primus*, *33*(1), 1-15. https://doi.org/10.1080/10511970.2021.2006378

van der Meer, N., van der Werf, V., Brinkman, W.-P., & Specht, M. (2023). Virtual reality and collaborative learning: a systematic literature review. *Frontiers in Virtual Reality*, *4*. https://doi.org/10.3389/frvir.2023.1159905

Wang, A., Thompson, M., Roy, D., Pan, K., Perry, J., Tan, P., Eberhart, R., & Klopfer, E. (2019). Iterative user and expert feedback in the design of an educational virtual reality biology game. *Interactive Learning Environments*, 1–18. https://doi.org/10.1080/10494820.2019.1678489

Wolf, M., Söbke, H., & Baalsrud Hauge, J. (2020). Designing augmented reality applications as learning activity. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 23–43). Springer. https://doi.org/10.1007/978-3-030-42156-4_2

Yan, L., Colleni, M., & Litts, B. K. (2020). Interacting across contexts: Augmented reality applications for developing the understanding of the Anthropocene. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 367–385). Springer. https://doi.org/10.1007/978-3-030-42156-4_19

Yemelyanova, D., Tadeush, O., Dushechkina, N., Masliuk, K., Malyshevskyi, O., & Demchenko, I. (2022). Formation of Professional Self-Determination of Future Teachers of Non-Language Specialties when Learning the English Language. *Romanian Journal for Multidimensional Education*, *14*(1), 305–321. https://doi.org/10.18662/rrem/14.1/520

Zhang, Q., Wang, K., & Zhou, S. (2020a). Application and practice of VR virtual education platform in improving the quality and ability of college students. *IEEE Access*, *8*, 162830– 162837. https://doi.org/10.1109/access.2020.3019262

Zhang, D., Wang, M., & Wu, J. G. (2020b). Design and implementation of augmented reality for English language education. In V. Geroimenko (Ed.), *Augmented reality in education* (pp. 217–234). Springer. https://doi.org/10.1007/978-3-030-42156-4_12

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.7
Cómo citar:
Polishchuk, O., Sameliuk, A., Honcharuk, L., Solodka, A., & Sherstiuk, N. (2024). Integration of web applications into content and language integrated learning (CLIL) programmes in higher education: Ukrainian context. *Revista Eduweb*, *18*(4), 104-120. https://doi.org/10.46502/issn.1856-7576/2024.18.04.7

Integration of web applications into content and language integrated learning (CLIL) programmes in higher education: Ukrainian context

La integración de aplicaciones web en programas de aprendizaje integrado de contenido y lengua (CLIL) en la educación superior: contexto ucraniano

Oleksandr Polishchuk
https://orcid.org/0000-0001-9306-617X
oleksandr_polishchuk@ukr.net
Ph.D. in Linguistics, Associate Professor of the Special Language Training Department, Military Faculty of International Relations and Law, Military Institute of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine.
Alina Sameliuk
https://orcid.org/0000-0003-1905-0422
alina.melnyk1991@ukr.net
Senior Lecturer of the Special Language Training Department, Military Faculty of International Relations and Law, Military Institute of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine.
Liliia Honcharuk
https://orcid.org/0000-0002-3965-2933
bondarenkoliliya1981@gmail.com
Ph.D. in Linguistics, Head of the Special Language Training Department, Military Faculty of International Relations and Law, Military Institute of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine.
Anzhelika Solodka
https://orcid.org/0000-0003-1703-7996
a.solodkaya1967@gmail.com
Doctor of Science, Professor, Professor of the Department of German Philology, Philological Faculty, V.O. Sukhomlynskyi Mykolaiv National University, Admiral Makarov National University of Shipbuilding, Mykolaiv, Ukraine.
Nadiia Sherstiuk
https://orcid.org/0009-0001-0356-3904
nadyasherstyuk@gmail.com
Senior Lecturer of the Department of Foreign Languages for Professional Purposes, Faculty of Hotel, Restaurant and Tourism Business, National University of Food Technologies, Kyiv, Ukraine.

Recibido: 09/10/24
Aceptado: 23/12/24

Abstract

The study analyses the impact of web-based applications on the effectiveness of content and language-integrated learning (CLIL) in higher education in the context of globalisation and the growing role of multilingualism in the European Union.

The study aimed to determine the impact of web-based applications on developing students' language competencies and their involvement in the learning process in CLIL. To achieve this goal, a systematic review of the scientific literature published in leading scientific databases from 2019 to 2024 was conducted. The study's results demonstrate that integrating web-based applications into the CLIL teaching process has a positive impact on students' language skills development and increases their motivation to learn. However, successfully implementing web technologies requires special training and adaptation to the learning environment.
The study's findings emphasise the importance of further studying web applications' potential in the context of CLIL and developing effective strategies for integrating them into the educational process.

Keywords: development of language and subject competence, digital learning environment, CLIL programmes in higher education, motivation enhancement.

Resumen

El estudio analiza el impacto de las aplicaciones basadas en la web en la eficacia del aprendizaje integrado de contenidos e idiomas (AICLE) en la enseñanza superior en el contexto de la globalización y el creciente papel del multilingüismo en la Unión Europea.
El estudio pretendía determinar el impacto de las aplicaciones basadas en la web en el desarrollo de las competencias lingüísticas de los estudiantes y su implicación en el proceso de aprendizaje en AICLE. Para lograr este objetivo, se realizó una revisión sistemática de la literatura científica publicada en las principales bases de datos científicas de 2019 a 2024.
Los resultados del estudio demuestran que la integración de aplicaciones basadas en la web en el proceso de enseñanza AICLE tiene un impacto positivo en el desarrollo de las competencias lingüísticas de los estudiantes y aumenta su motivación para aprender. Sin embargo, aplicar con éxito las tecnologías web requiere una formación especial y una adaptación al entorno de aprendizaje.
Las conclusiones del estudio subrayan la importancia de seguir estudiando el potencial de las aplicaciones web en el contexto del AICLE y de desarrollar estrategias eficaces para integrarlas en el proceso educativo.

Palabras clave: desarrollo de competencias lingüísticas y temáticas, entorno digital de aprendizaje, programas AICLE en la enseñanza superior, aumento de la motivación.

Introduction

In recent years, the CLIL (Content and Language Integrated Learning) method has become widespread in higher education, particularly in the context of globalisation and integrating foreign language teaching with academic disciplines.

CLIL involves the simultaneous teaching of subject content and a foreign language, which creates unique opportunities for developing students' language skills in real-life contexts of academic disciplines (Hubal, 2023). This approach promotes deeper learning of the academic material and improves students' communication skills, preparing them for intercultural interaction in a globalised society. Learning a language through subject content allows students to gain knowledge in specific areas, which increases their motivation and engagement in the learning process (Yuhan, 2017).

However, the successful implementation of CLIL in higher education requires detailed research on its effectiveness, requirements for teacher training and curriculum adaptation. This article discusses educational institutions' main advantages and challenges when implementing the CLIL method. It analyses its impact on the training of highly qualified specialists in the modern educational environment. Content and language-integrated learning (CLIL) is an innovative pedagogical approach that combines the development of language skills with the acquisition of content in specific disciplines. This approach significantly increases the level of intercultural communication, students' cognitive abilities and knowledge of specific norms and rules related to the language and subject area (Jiménez-Benavides, 2023).

Integrating web applications into CLIL can significantly enhance this approach in higher education. Using online resources creates an opportunity to develop interactive learning materials that engage students and promote their active participation. Thanks to digital platforms, teachers can offer a variety of learning modalities, including videos, interactive exercises, and online discussions, which increase students' interest and motivation to learn.

Historically, CLIL emerged in the 1990s as an initiative to promote bilingual education in Europe (Paran, 2013). Since then, the approach has gained widespread acceptance, expanding its scope to higher education and beyond the European context. Current research confirms that CLIL promotes language skills and improves students' academic, cultural and cognitive abilities (Tinedo Rodríguez, 2022).

Web-based applications can be important tools to support CLIL learning objectives. They allow teachers to adapt learning materials to meet students' needs, stimulating critical thinking and flexibility in learning (Merchán Cedillo & Mora Aguilar, 2024). For example, collaboration and information-sharing platforms can facilitate intercultural exchange and the development of communication skills.

In Europe and elsewhere, bilingual education began to develop in the 1970s, focusing on learning a second or minority language. For example, in France, such programmes allowed children from linguistic minorities to study in their mother tongue (Adam, 2019). These initiatives have been seen to enrich the educational process, mainly to protect minority languages (Cortier & Puren, 2008). It is important to note that the second language is complemented, not replaced, with the mother tongue. Thus, in this context, the European Commission called for implementing national action plans for early language acquisition (Holdsworth, 2003). In some countries, the emphasis is on introducing modern languages in the early stages of education. Numerous European initiatives have encouraged educational institutions to integrate CLIL into their curricula. In contrast to immersive programmes that strive for perfect bilingualism (Petit, 2020), the CLIL approach emphasises teaching some subjects in a foreign language, while the teacher can use the mother tongue if necessary. CLIL promotes dual learning, where subjects are taught alongside the foreign language, allowing the language to be used as a learning tool (Martens et al., 2023).

The integration of innovative web technologies within CLIL programmes aligns with findings by Leleka et al. (2024), who emphasize the importance of web-oriented approaches in health-preserving education, highlighting their efficacy in fostering engagement and practical application. This approach creates opportunities for integrating web-based applications into learning, allowing students to practice the language in authentic situations and contexts. Thus, CLIL becomes a platform for effective language skills development, stimulating interdisciplinary and more profound learning (Herrera, 2024). Thus, integrating web-based applications into CLIL programmes in higher education opens up new opportunities for creating an inclusive and dynamic learning environment that prepares students for the challenges of the globalised world.

A significant amount of research has confirmed the effectiveness of the CLIL method in higher education. However, research gaps still exist:

There is a lack of data demonstrating the specific impact of web application integration on the success of the CLIL approach in higher education.

There is a lack of generalisations from the practical experience of using web-based applications by cadets trained under grant programmes or in specific disciplines.

The system of assessment of learning outcomes using CLIL and interactive technologies has not yet developed standards that would be accepted internationally.

Research problem

The study's relevance is due to the growing interest in multilingualism and innovative teaching methods in higher education. CLIL, as a methodology that combines the study of a subject area and a foreign language, has significant potential for developing students' language competencies and improving the quality of the educational process.

The CLIL (Content and Language Integrated Learning) method requires a detailed study of its effectiveness and possible challenges associated with its implementation in higher education. Research should focus on how CLIL affects the development of students' language skills, academic performance, and intercultural communication, as well as teacher training and the adaptation of curricula to the needs of the modern learning environment. It is also essential to find out how integrating web-based applications can improve this approach by providing more opportunities for active learning.

The subject of the study is content and language-integrated learning (CLIL) as an innovative teaching methodology in higher education. The research is a comprehensive analysis of the effectiveness of CLIL, identifying its strengths and weaknesses and determining the factors that influence the success of the implementation of this methodology. In particular, the study focuses on such aspects as the impact of CLIL on the development of students' language competencies and academic performance, preparation of teachers to work in CLIL, adaptation of curricula and the use of digital technologies in the learning process.

Research Focus

This study focuses on teacher professional development and the skills required for the successful implementation of CLIL (Content and Language Integrated Learning). A key aspect is adapting curricula in accordance with CLIL principles, which allows for the integration of content training with the development of language competencies.

The study also looks at how curricula can be transformed to integrate disciplinary content and foreign language learning effectively. This includes developing innovative methodologies and teaching materials that contribute to the development of student's language skills, which are important for their success in a globalised society. Particular attention is paid to the role of digital technologies and web applications in enhancing the effectiveness of the CLIL learning process. Digital resources and tools provide interactivity and personalised learning, which contributes to increased student engagement and effective achievement of learning objectives.

It assesses how web-based applications facilitate interaction between students and teachers, creating a dynamic learning environment that increases learning motivation and improves learning. The final section of the study focuses on analysing the challenges associated with integrating CLIL into the educational process. The main difficulties are technical problems, cultural and linguistic barriers, limited resources and methodological approaches. Based on the review of scientific sources, strategies are proposed to overcome these challenges and increase the effectiveness of CLIL implementation in the higher education system. This study focuses on the professional development of teachers and the skills required for the successful implementation of CLIL (Content and Language Integrated Learning). A key aspect is the adaptation of curricula by CLIL principles, which allows for integrating content training with the development of language competencies.

Research Aim

The purpose of the article is to analyse the potential and challenges of applying the CLIL (Content and Language Integrated Learning) methodology in the Ukrainian higher education system and explore the possibilities of adapting this approach to local conditions. Modern technologies and web-based applications can radically change the learning process in the context of CLIL, contributing to deeper learning, increasing students' motivation and developing skills that meet the requirements of the globalised world. Technology

integration makes the learning process more interactive, individualised and flexible, which is especially important in CLIL programmes where students simultaneously master a subject and learn a foreign language.

This study examines the introduction of CLIL in the Ukrainian higher education system. It aims to highlight the critical aspects of its integration into the curriculum and assess its impact on the quality of education. CLIL, as an innovative approach, combines the study of subject content and foreign language acquisition, which allows students to develop academic and linguistic competences simultaneously. However, the introduction of CLIL in Ukrainian higher education institutions is accompanied by numerous challenges, including problems with curricula and teacher training.

A comparative analysis of teaching effectiveness using CLIL and traditional methods is planned to achieve this goal. The scientific literature will also be analysed to identify current trends in the development of CLIL and best practices.

Research questions

1. How do web applications affect students' academic performance in CLIL programmes?
1. What impact do web applications have on developing students' communication skills?
2. How do web applications affect students' motivation to learn?
3. What are teachers' main challenges when integrating web applications into CLIL programmes?

Theoretical Framework or Literature Review

Theoretical foundations of CLIL (Content and Language Integrated Learning)

Content and language-integrated learning (CLIL) is becoming an increasingly common approach in higher education. It allows for the combination of foreign language learning with the acquisition of various academic disciplines. CLIL is a method of bilingual learning that uses a foreign language as a tool for mastering subject knowledge (Marsh & Pérez, 2024). Thanks to this approach, students improve their linguistic competencies and deepen their knowledge in the relevant fields.

According to Waloyo, Khoiriyah & Farah (2021), a critical factor in the successful implementation of CLIL is the integration of web applications, which can significantly improve the efficiency of the learning process. Using online resources contributes to creating interactive learning materials that increase student motivation and provide access to relevant information (Štefková & Danihelová, 2023). Video conferencing platforms, interactive whiteboards, and online courses make classes more dynamic and attractive to students.

As modern students are often exposed to a large amount of information through the media and the Internet, the CLIL method helps them navigate this information flow by developing critical thinking and analytical skills (Li & Zhang, 2022). Integrating web applications into the learning process allows teachers to create various tasks that stimulate discussion, teamwork, and independent activity (Destari & Kusumawati, 2023). CLIL technology is developing to integrate educational and scientific institutions into the global community. This approach aims to develop social, cultural, cognitive, linguistic and academic skills, which contributes to achieving both subject and language outcomes (DelliCarpini, 2021). CLIL teachers should use the latest techniques and strategies to improve student achievement (Morgado et al., 2019).

In addition, according to Kaewkamnerd, Dibyamandala, Mangkhang & Khuankaew (2024), CLIL technology is becoming increasingly popular among future teachers, most of whom integrate CLIL lessons with digital applications. According to a survey conducted by Junior (2020), the most commonly used learning tools are Quizizz, Kahoot and LearningApps.

The theoretical underpinnings of CLIL pedagogy are diverse and not reducible to a single approach or model. It is an interdisciplinary approach based on socio-constructivist theory that emphasises the importance of learning at the individual and social levels (Nikula et al., 2016).

CLIL in higher education contributes to developing disciplinary, linguistic, cognitive and intercultural skills (Marsh & Pérez, 2024). Studies point to the cognitive benefits of implicit language learning, which enables reflective analysis of language material (Banegas & Zappa-Hollman, 2023). The cognitive component encompasses the processes of reflection and awareness of the content within the learning material.

Empirical research in CLIL pedagogy demonstrates the diversity of its practices (Barçante, 2020), which is related to the specificity, intensity and didactic priorities. Researchers identify three main models of CLIL pedagogy: The first is short language classes two or three times a week lasting 20-30 minutes with songs and games (Babault et al., 2022); the second model is modular, where individual topics of a discipline (e.g. mathematics) are taught in a foreign language (Silva, 2022); the third is the whole teaching of one or more subjects in a foreign language during the school year (Dalton-Puffer et al., 2022).

The results of research and implementation of CLIL in higher education emphasise its positive effects. For example, Porto (2021) notes that this approach contributes to developing language skills and deeper learning. According to research, students enrolled in CLIL programmes demonstrate better language competence and a better understanding of both their native and foreign languages (Kuhna, 2019). It also increases student motivation and encourages active participation in learning.

Improvements in CLIL technology can be made through teacher training, the introduction of new methods, and the provision of guidelines for educational institutions (Porcedda & González-Martínez, 2020). To ensure high-quality education, it is important that teachers are trained in CLIL methods and familiar with technologies that support interactive learning (O'Connell & Chaplier, 2021; Radziievska et al., 2022). This includes mastery of bilingual teaching methods and the ability to adapt learning materials to students' needs.

Thus, CLIL is an effective tool for improving learning in higher education, especially when integrated with modern technologies. Web-based applications are becoming essential in creating an engaging and interactive learning environment that prepares students for the challenges of today's globalised world.

Methodology

Data Design

The basic method used to achieve the research goal was a literature review. This method identified existing practices, approaches, and challenges when integrating web applications into content and language-integrated learning (CLIL). In addition, the study is based on empirical observations and analysis of pedagogical practice at the Military Faculty of International Relations and Law of the Military Institute of Taras Shevchenko National University of Kyiv (Kyiv, Ukraine).

Various sources, such as scientific articles, monographs, and analytical reports, were used to collect information. The main databases from which the research materials were taken are Scopus, Web of Science, and Google Scholar. This ensured the reliability and relevance of the information collected.

Objectivity in selecting sources was ensured by excluding materials produced in countries with potential political bias. This allowed us to minimise the risk of subjective factors influencing the research results by focusing on neutral and scientifically sound sources. The participants in the systematic review were scientists, educators, and researchers who specialise in integrating interactive technologies into the learning process to improve the quality of education and develop scientific competencies. The selection of participants was based on their contribution to the field through publications in peer-reviewed journals and participation in educational practices that incorporate technology. The selection process followed a

systematic search strategy aimed at including relevant and diverse studies that highlight interactive technologies in the educational environment. The final sample consisted of 50 peer-reviewed articles selected to comprehensively analyse current trends and practices in the use of interactive technologies in education. This sample size was sufficient to provide comprehensive information on the main thematic areas, supported by content richness and data triangulation.

Key themes and terms such as 'development of language and subject competence', 'digital learning environment', 'CLIL programmes in higher education', 'development of language skills', and 'motivation enhancement' were used to guide the literature search. The information was collected based on its relevance to the research questions, which included research design, sample characteristics, and results on the effectiveness of interactive technologies in education.

Data Selection

The search for scientific literature was carried out using keywords such as "web applications," "CLIL," and "interactive learning." The initial search yielded 250 results.

Only sources that contained specific information about web-based applications or interactive technologies in education were selected. After selection, 150 sources were removed, leaving 100 relevant articles.

To determine the study's timeframe, it was established that only publications from the last five years would be included. Out of the 100 selected sources, 50 publications published before 2019 were excluded, leaving 50 articles (Fig. 1).

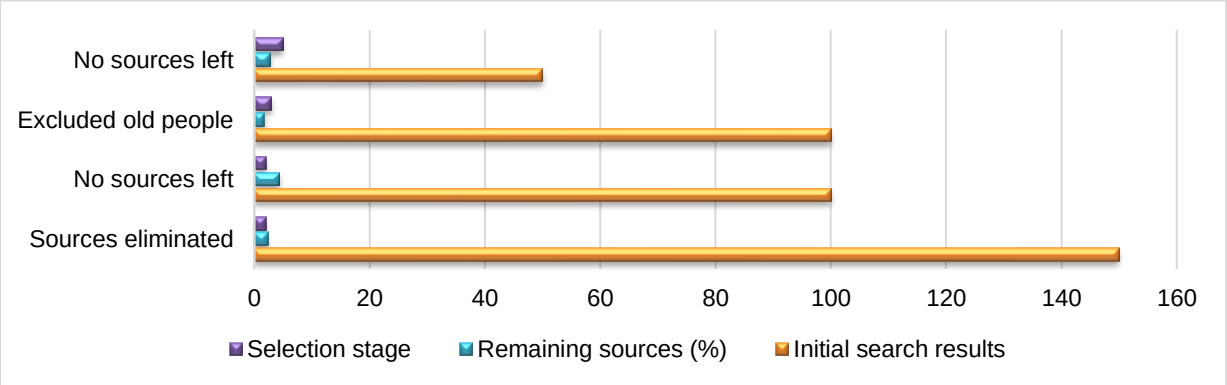

Fig. 1. Selection of the database for análisis.
Source: authors' own development.

Additional criteria were applied, such as a focus on interactive technologies in foreign language teaching. After this filtering, 50 sources remained, which became the basis for further analysis.

To process the collected data, content analysis was used to identify the main approaches to integrating web applications into CLIL teaching. The analysis revealed key themes and issues that highlight the practical aspects of implementing these technologies.

Observing the classes collected empirical data, which helped collect qualitative data on the author's web application experience (Fig. 2).

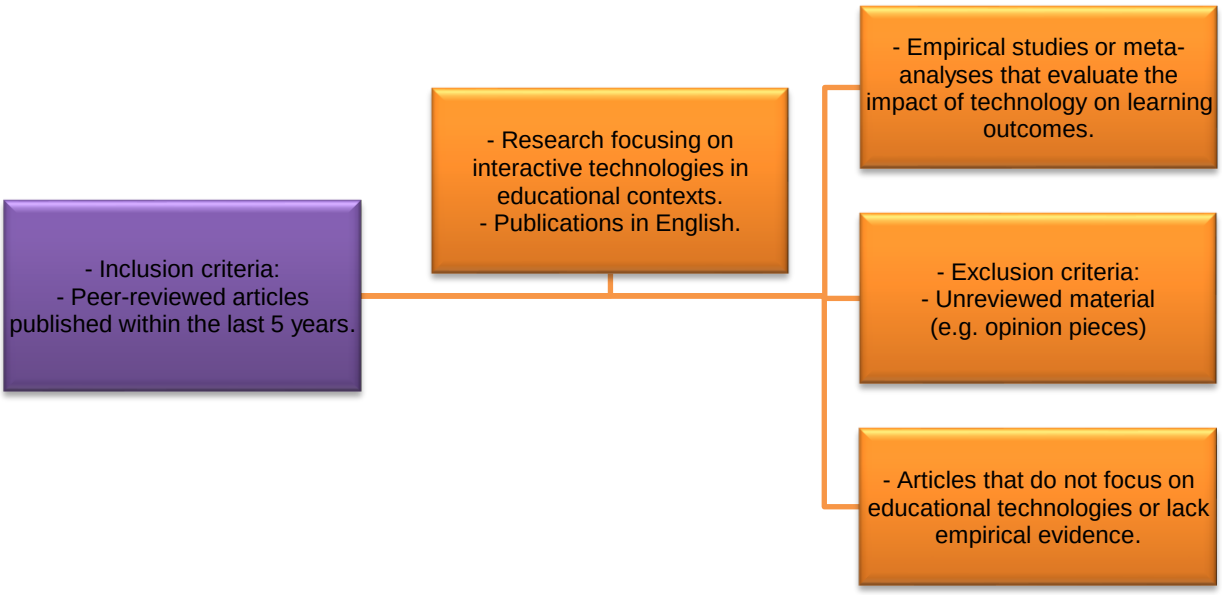

Fig. 2. Criteria for selecting data for análisis.
Source: authors' own development

The data was collected using a pre-designed coding system focused on the research objectives, methodology, sample characteristics, interventions and outcomes. The extracted data were synthesised through thematic analysis, which allowed the results to be classified into subthemes, approaches, and challenges related to integrating web applications into the CLIL methodology.

The results of the analysis of scientific sources convincingly demonstrate the effectiveness of introducing web applications into the educational process using the CLIL method, emphasising the importance of modern technologies in improving the quality of learning and developing students' language skills.

The analysed studies examined the impact of web applications, interactive technologies, and CLIL methodology in the educational environment on increasing students' motivation, engagement, and communication competence.

Ethics

The paper provides a comprehensive and balanced literature review, reflecting both the potential benefits and limitations of integrating web-based applications into CLIL programmes. The authors' actions contributed to intellectual honesty to prevent bias in the interpretation of the effectiveness of web-based tools in the educational environment.

Limitations

The study has the following limitations. First, it focuses on certain time periods. The analysis covered only publications between 2019 and 2024, which may lead to the omission of important information and experience gained in previous years, which could also have influenced the development of CLIL practices. Second, geographical limitations. Despite the involvement of Ukrainian and international research, the results may be overly concentrated on certain countries or regions of Europe, which may limit the generalisability of these findings at the global level.

Finally, the analysis was based on a literature review, which may contain some subjectivity or bias of the authors of the included publications, as well as variations in methodological approaches used in different sources.

Results

Integrating web applications into content and language-integrated learning (CLIL) programmes in higher education is essential to the modern educational process. The use of digital tools and web applications improves the quality of learning and creates a favourable environment for the simultaneous acquisition of professional knowledge and foreign language learning (Kukulska-Hulme et al., 2024). Through interactive technologies, students can better understand the material, access a wide range of resources, and engage in intercultural communication.

In CLIL programmes, web-based applications can create virtual classrooms and conduct online discussions, group projects and tests. Interactive platforms such as Moodle, Google Classroom, or specialised CLIL applications allow you to organise practical work with large amounts of information, automate assessment processes, and maintain constant feedback between students and teachers (Şentürk, 2021).

Using web-based technologies in CLIL teaching contributes to developing critical thinking, problem-solving, collaboration and creativity skills, which are essential for academic success and professional training in a globalised world.

The staff of the Department of Special Language Training of the Military Faculty of International Relations and Law of the Military Institute of Taras Shevchenko National University of Kyiv (Kyiv, Ukraine) are actively implementing pilot projects and conducting research in the field of teaching foreign languages, including English as a foreign language. The analysis of scientific literature and personal observations made it possible to identify the main advantages of using the CLIL method and define its goals and expected results. The research conclusions show that the results are similar to those in other European countries. The observations are focused on the following main aspects (Fig. 3):

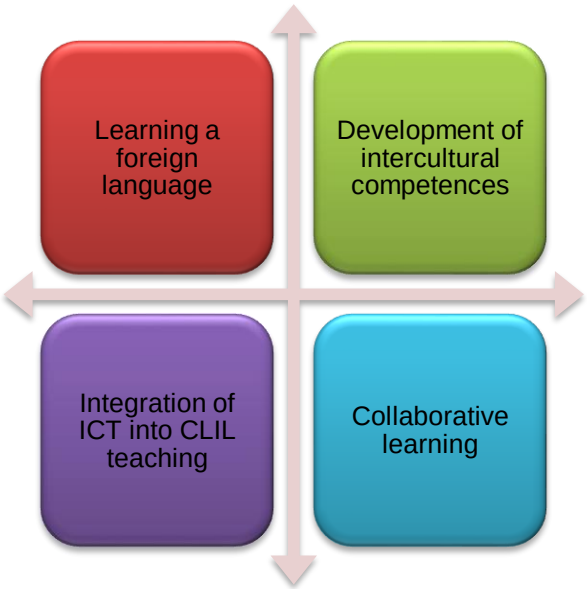

Fig. 3. The main themes in the integration of CLIL in higher education.
Source: authors' own development.

Pilot projects are usually implemented in senior years, where students have a higher level of foreign language proficiency. In addition to English, German and French are also used as target languages (Fakhar et al., 2024; Paweloszek et al., 2022).

In the Ukrainian context, CLIL is used to teach such disciplines as international law, geopolitics, and military affairs. These projects are implemented with the support of university structures and educational advisors. Teaching is often conducted by foreign language teachers in collaboration with experts in the relevant fields. Teaching materials are developed by teachers themselves, as there are not enough specialised textbooks for CLIL in Ukraine.

Public higher education institutions in Ukraine are divided into general and experimental, with the latter offering innovative learning models. In recent years, several CLIL projects have been implemented in higher education aimed at improving language skills and developing students' intercultural competencies.

In particular, the Military Faculty of International Relations and Law of the Military Institute of Taras Shevchenko National University of Kyiv (Kyiv, Ukraine) implemented projects in which students learned English through interactive classes and online resources. These initiatives helped to improve language skills, actively engage students in the learning process, and develop their independence.

After completing the pilot projects on the use of CLIL technology, the staff of the Department of Special Language Training of the Military Faculty of International Relations and Law conducted an analysis of its implementation in the educational process. The study covered students' views on the combination of subject and language learning, as well as their attitudes towards the integration of these approaches. An important role in the study was played by the use of web-based applications and the experience of implementing CLIL technology in educational institutions. In particular, the difficulties and advantages of integrated learning were studied, as well as students' suggestions for its improvement.

The results of the study showed that a significant number of students positively perceive CLIL technology, emphasising its importance for the learning process and the development of intercultural competences.

The integration of CLIL technology at the Military Faculty of International Relations and Law of the Military Institute of Taras Shevchenko National University of Kyiv (Kyiv, Ukraine) has had a positive impact on students' training, allowing them to combine language learning with disciplines that are important for their professional activities. Many students believe that this integration of subject and language learning contributes to the development of critical thinking and independent work, introducing innovations in the learning process, increasing cognitive activity and motivation, and making learning more interesting and effective.

The integration of web applications into content and language-integrated learning programs also contributes to the successful implementation of CLIL (Kic-Drgas et al., 2024). The use of modern technologies provides students with the opportunity to acquire knowledge of disciplines and simultaneously develop language skills in an interactive environment. This creates new opportunities for improving professional competencies and enhancing the quality of education, which is especially important for future professionals in the field of international relations.

Faculties are actively using web-based applications such as Quizizz, Kahoot, LearningApps.org, Wordwall, Wooclap and Google Classroom. CLIL technology is gradually being introduced in Ukraine, but students have different opinions about its effectiveness. Some of them are against it, while others support this approach, believing that it should be introduced from the beginning of their studies, as it helps them to master the subject and the foreign language faster. Innovations are always necessary; as the better the education system develops, the more it contributes to the improvement of students' skills.

Students noted that the integration of subject and language learning has its challenges, including the need

to constantly update the methodology, high time costs, the risk of misunderstanding the material, the need for additional training for students and teachers, and a lack of focus on implementation. However, among the advantages of learning a foreign language, students noted the comprehensive development of the individual. In this context, the authors, based on their own experience, offer recommendations for improving the CLIL technology (Table 1).

Table 1.
Prospects for improving CLIL technology

Expanding teacher training	Conducting trainings and seminars for teachers so that they can effectively use CLIL in their practice.
Development of standardised training materials	Creation of textbooks and resources specifically adapted for CLIL to help teachers prepare classes.
Integration of modern technologies	Use of digital tools and web applications to support the learning process and increase student engagement.
Interdisciplinary approach	Encourage collaboration between teachers of different subjects to create integrated courses that combine content and language.
Regular monitoring and evaluation	Introduce a CLIL performance evaluation system to identify successful practices and areas for improvement.
Student engagement	Active involvement of students in the learning process, including their feedback and suggestions for improving the technology.
Efficiency studies	Conducting research that evaluates the impact of CLIL on learning outcomes in order to justify its use in the education system.
Sharing successful experiences	Organise conferences and exchange of experience between higher education institutions to promote successful CLIL implementation practices.

Source: authors' own development

Analysing the experience of introducing CLIL technology at the Military Faculty of International Relations and Law of the Military Institute of Taras Shevchenko National University of Kyiv (Kyiv, Ukraine), it can be argued that the number of professionals who are proficient in CLIL and actively use it in every class remains insufficient. Ukraine trains specialists with profound knowledge of foreign languages, but despite the support of this technology by many students, a significant number of students of humanities specialities do not show the same interest. This is partly due to the specifics of the disciplines.

Discussion

Thus, in the above paper, the literature analysis allowed us to answer the key questions related to the integration of web applications into content and language integrated learning (CLIL) programmes in higher education.

Firstly, research has shown that the use of web-based applications can significantly contribute to improving students' understanding of academic material. Digital tools provide access to interactive and visualised resources that make complex concepts easier to grasp, and improve test scores and other academic performance.

Secondly, the literature analysis revealed that the integration of digital tools has a positive impact on the development of student's language and communication skills in the context of CLIL. The use of web-based applications for group discussions, interactive exercises, and collaborative work in online environments contributes to the more effective acquisition of language competence and improved communicative interaction.

Third, we analysed how digital tools affect students' motivation to learn. The use of web-based applications makes the learning process more engaging and dynamic, increasing students' interest and facilitating their active participation in the educational process.

The study also revealed the main challenges faced by teachers when implementing web-based applications in CLIL. The main difficulties include technical problems, insufficient knowledge of new teaching methods and resource management, which requires additional training and support for teaching staff.

Thus, the literature analysis not only confirmed the positive impact of web-based applications on the educational process in CLIL, but also highlighted the main challenges faced by teachers in the process of their integration.

These results correlate with the work of Byrko et al. (2022), who emphasise that CLIL is still an innovation that is used only by some higher education institutions. The problem of adapting CLIL to Ukrainian curricula has also been studied. The problem is that most of them focus on preparing students for international language certifications such as IELTS or DELF, which is different from CLIL teaching (Boichenko et al., 2023). In related works, researchers also find that there is a lack of necessary teaching materials and resources for CLIL implementation, which becomes a significant obstacle to its implementation.

The results are partially consistent with the findings of studies conducted in European countries. For example, Papaja (2023) notes that the introduction of CLIL has become particularly popular in European higher education due to the dominance of English among foreign languages. However, it is worth emphasising the difference between CLIL and English as a medium of instruction (EMI), which was also noted in this study. This distinction allows for a deeper analysis of the specifics of each approach and the selection of the most appropriate methods for the Ukrainian context.

On the other hand, the results of this study differ somewhat from the findings of Amor, Tinedo-Rodríguez and Osuna-Rodríguez (2023), who argue that the implementation of CLIL in European universities is more organised and supported at the state level. While CLIL is increasingly being used in Europe, Ukrainian teachers face challenges due to insufficient training, lack of methodological frameworks and limited resources. In this study, these problems were identified as some of the main obstacles to the successful integration of CLIL into the higher education system.

Interpretation of the results of this study indicates that although CLIL has significant potential to improve the quality of learning, its implementation requires a systematic approach. One of the unexpected findings of our study is that, despite limited resources and the lack of ready-made teaching materials, teachers show a high interest in this methodology (Myronenko et al., 2024). They are ready to develop didactic materials on their own, although it requires considerable effort and time. As Chashechnikova et al. (2024) emphasise, the integration of innovative technologies into educational practices fosters critical thinking skills, an essential component for students' cognitive and professional development. Furthermore, the study showed that students enjoy the interactive nature of CLIL classes, which contributes to the development of their language and academic skills. This finding confirms the results of other studies, such as Galán-Rodríguez et al. (2024), who emphasise the importance of an interactive approach and teachers' dual competence in language and subject matter didactics. However, in order to ensure effective teaching, it is necessary to develop a teacher training system that meets the specifics of CLIL. Web-based applications such as interactive learning platforms, video conferencing, virtual laboratories, and mobile language learning can make the learning process more dynamic and convenient for students. For example, platforms such as Kahoot, Quizlet or Edpuzzle promote active engagement of students in the learning process by allowing them to complete tasks interactively, compete with each other, watch videos with integrated questions and discuss topics in real-time (Navarro Henares, 2020; Settelmeyer et al., 2019).

Interactive platforms provide immediate feedback, which plays an important role in consolidating knowledge and maintaining student interest. For example, Kahoot, as a gaming platform for creating quizzes, not only allows students to demonstrate their knowledge but also promotes competition in a fun and motivating atmosphere (Zainuddin et al., 2024). This, in turn, helps to develop teamwork skills, critical thinking, and responsiveness. The use of such platforms makes lessons much more interactive than traditional teaching methods, which encourages students to be more active in learning.

According to Rebolo Roca (2021), Quizlet, as a flashcard tool, promotes the memorisation of new terms and concepts through repetition, using a variety of formats such as quizzes, games and flashcards. This is extremely useful for learning new vocabulary in a CLIL context where students need to learn both subject material and a new language at the same time. Students have the opportunity to create their own sets of flashcards, adapting the material to their individual needs and level of proficiency (Vonitsanos et al., 2024). Edpuzzle allows teachers to integrate videos with questions, which allows students to better absorb information through visual and audio formats (Díez-Pascual & Díaz, 2020). Students can pause the video, answer questions, and receive instant feedback, which helps them gain a deeper understanding of the topic. The study by Hegde et al. (2022) shows that the use of such web-based applications significantly increases student motivation, improves learning efficiency, and provides greater flexibility in the process of acquiring new knowledge.

Like any study, the present one has certain limitations. Firstly, the limited number of educational institutions implementing CLIL in Ukraine affected the generalisability of the results. Secondly, due to the lack of resources and teaching materials, many teachers were unable to fully implement CLIL, which could affect the quality of the data collected. Thirdly, the study involved mainly students of humanities, which may limit the applicability of the results to other fields of study.

Despite these limitations, the study has made a significant contribution to the development of the scientific debate on the implementation of CLIL in higher education in Ukraine. It has identified key problems and challenges faced by Ukrainian teachers and students and suggested possible ways to overcome them. The scientific novelty of the study lies in the fact that the specifics of CLIL implementation in the context of the Ukrainian education system, which has not been the subject of a comprehensive analysis before, were considered in detail.

The results of the study indicate that the adaptation of CLIL in Ukrainian higher education is possible, but it requires more resources, teacher training and the creation of specialised teaching materials. The use of web-based applications and other modern technologies can be a key factor for the effective implementation of this method. This study can serve as a basis for further research in this area, in particular on the impact of CLIL on students' academic achievement in different disciplines.

Integrating CLIL into higher education is a promising approach to developing students' language and academic skills. However, its successful implementation requires solving a number of problems, including providing teachers with the necessary resources and materials, as well as the possibility of taking specialised courses to prepare them for teaching using this methodology. Further research should focus on finding the best ways to integrate CLIL into various curricula in Ukraine.

Conclusions

Thus, the study results show that technologies significantly increase the interactivity of the educational process, contribute to improving students' language skills and provide an opportunity to individualise learning. The use of web-based applications, such as Kahoot and Quizlet, positively impacts student engagement in learning, allowing them to complete tasks in the form of competitions and discuss topics in real-time. Students who use online resources to learn foreign languages demonstrate a higher level of language competence than those who study using traditional methods. Technology provides students access to various information sources, which contributes to developing their critical thinking and analytical skills. Mobile language learning applications allow students to choose the pace and level of complexity of the learning material, which contributes to a more profound learning experience. Technology also facilitates preparing lessons and providing feedback, but teachers must be trained to use it effectively.

The study's scientific novelty lies in its comprehensive assessment of CLIL's effectiveness in the Ukrainian context, with an emphasis on the role of digital technologies in the educational process.

The study's practical significance lies in the development of recommendations for improving the practice of teaching using the CLIL methodology in Ukraine's higher education institutions (Budko et al., 2024). The results can be used to develop teaching aids, conduct teacher training, and adapt curricula.

In this context, further research could focus on the impact of specific web-based applications on students' learning outcomes in CLIL and different disciplines and on a detailed analysis of their contribution to the development of language and academic competence. It is also essential to investigate how different levels of resource provision affect the effectiveness of technology integration in the learning process.

It is promising to develop recommendations for teachers on integrating technology into CLIL, particularly in assessing learning outcomes and providing quality feedback using digital tools.

Thus, further research should contribute to improving the methodological approaches and practices for introducing technologies into the educational process, which will ensure more effective and efficient learning within the CLIL methodology.

Bibliographic references

Adam, C. (2019). Scolarisation bilingue et appropriation d'une langue (minoritaire). *Revue TDFLE*, *1*(1). https://revue-tdfle.fr/articles/actes-1/134-scolarisation-bilingue-et-appropriation-d-une-langue-minoritaire

Amor, M. I., Tinedo-Rodríguez, A. J., & Osuna-Rodríguez, M. (2023). The Interaction between Language Skills and Cross-Cultural Competences in Bilingual Programmes. *Languages*, *8*(3), 181. https://doi.org/10.3390/languages8030181

Babault, S., Grabowska, M., & Rivens Mompean, A. (2022). Apprentissage formel et informel des langues. Quelles articulations? *Recherches en didactique des langues et des cultures. The Acedle Notebooks*, *20*(20-1). https://doi.org/10.4000/rdlc.11780

Banegas, D. L., & Zappa-Hollman, S. (Eds.). (2023). *The Routledge handbook of content and language integrated learning*. Taylor & Francis. https://doi.org/10.4324/9781003173151

Barçante, M. (2020). Planejamento e Implementação de Curso Online CLIL no Centro Estadual de Educação Tecnológica Paula Souza: vislumbrando EMI. *Revista CBTecLE*, *4*(2), 116-126. https://revista.cbtecle.com.br/CBTecLE/article/view/281

Boichenko, M., Churychkanych, I., Kulichenko, A., Shramko, R., & Rakhno, M. (2023). Mind maps to boost the learning of English as L2 at higher education institutions in Ukraine. *Amazonia Investiga*, *12*(70), 229-240. https://doi.org/10.34069/AI/2023.70.10.21

Budko, L., Maksymovych, G., & Shulga, T. (2024). *Content and language integrated learning model in teaching a foreign language at a non-language university.* Editorial Helvética. https://dspace.nau.edu.ua/handle/NAU/65222

Byrko, N., Tolchieva, H., Babiak, O., Zamsha, A., Fedorenko, O., & Adamiuk, N. (2022). Training of teachers for the implementation of universal design in educational activities. *AD ALTA: Journal of Interdisciplinary Research, 12*, 117-125. http://surl.li/kjizuh

Chashechnikova, O., Odintsova, O., Hordiienko, I., Danylchuk, O., & Popova, L. (2024). Innovative technologies for the development of critical thinking in students. *Amazonia Investiga*, *13*(81), 197–213. https://doi.org/10.34069/ai/2024.81.09.16

Cortier, C., & Puren, L. (2008). French and regional and/or minority languages: a difficult convergence. Benchmarks. *Research in teaching French as a mother tongue, (38)*, 63-80. https://journals.openedition.org/reperes/390

Dalton-Puffer, C., Hüttner, J., & Llinares, A. (2022). CLIL in the 21st Century: Retrospective and prospective challenges and opportunities. *Journal of Immersion and Content-Based Language Education*, *10*(2), 182-206. https://doi.org/10.1075/jicb.21021.dal

DelliCarpini, M. (2021). Developing the C in content and language integrated learning: Teacher preparation that builds learners' content knowledge and academic language through teacher collaboration and integrated pedagogical training. In *International perspectives on CLIL* (pp. 217-237). Cham:

Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-030-70095-9_11

Destari, D., & Kusumawati, E. A. (2023). The Digital Teaching and Learning on Islamic Education Institutions and Their Sustainability in the New Normal Era. *Aqlamuna: Journal of Educational Studies*, *1*(2), 218-243. https://doi.org/10.58223/aqlamuna.v1i2.251

Díez-Pascual, A. M., & Díaz, M. P. G. (2020). Audience response software as a learning tool in university courses. *Education Sciences*, *10*(12), 350. https://doi.org/10.3390/educsci10120350

Fakhar, H., Lamrabet, M., Echantoufi, N., & Ajana, L. (2024). Towards a New Artificial Intelligence-based Framework for Teachers' Online Continuous Professional Development Programmes: A Systematic Review. *International Journal of Advanced Computer Science & Applications*, *15*(4). https://doi.org/10.14569/ijacsa.2024.0150450

Galán-Rodríguez, N. M., Fraga-Viñas, L., Bobadilla-Pérez, M., Gómez-Sánchez, T. F., & Arcas, B. R. (2024). Methodological training in plurilingual education in the Spanish Higher Education training programmes: are pre-service teachers ready for CLIL? Formación metodológica en educación plurilingüe en los programmeas de Educación Superior en España: ¿Está el profesorado en formación preparado en AICLE? *Revista de Educación*, *403*, 31-58. https://doi.org/10.4438/1988-592X-RE-2024-403-611

Hegde, M. N., Kanchan, J., Ganaraj, K., Madhu, R., Shetty, S. S., & Rajatha, K. (2022). Digital Tools to Promote Formative Assessment in the Classroom. In *EdTech Economy and the Transformation of Education* (pp. 53-64). IGI Global. https://doi.org/10.4018/978-1-7998-8904-5.ch004

Herrera, R. M. S. (2024). CLIL Methodology as an Educational Approach to Support Productive Skills for EFL. *Lecturas: Educación Física y Deportes*, *29*(311). https://doi.org/10.46642/efd.v29i311.7266

Holdsworth, P. (2003). Promoting language learning and linguistic diversity in Europe. *Sèvre International Education Reviews, (33)*, 107-115. https://journals.openedition.org/ries/1736

Hubal, H. M. (2023). Improving references and footnotes in mathematical and other texts by creating macros in the LaTeX programming language. *International Journal on Information Technologies & Security, 15*(3), 15-22. https://doi.org/10.59035/fbcy3490

Jiménez-Benavides, A. V. (2023). El aprendizaje integrado de contenido con el lenguaje en el aprendizaje de inglés. Reflexiones docentes. *Revista De Investigaciones De La Universidad Le Cordon Bleu*, *10*(1), 23-25. https://doi.org/10.36955/RIULCB.2023v10n1.003

Junior, J. B. B. (2020). Assessment for learning with mobile apps: exploring the potential of quizizz in the educational context. *International Journal of Development Research*, *10*(01), 33366-33371. https://www.journalijdr.com/assessment-learning-mobile-apps-exploring-potential-quizizz-educational-context

Kaewkamnerd, K., Dibyamandala, J., Mangkhang, C., & Khuankaew, S. (2024). Building Autonomy in English Language Learning: Integrating Digital Technology with CEFR-CLIL in Thai EFL Education. *Korean Journal of English Language and Linguistics*, *24*, 660-688. https://doi.org/10.15738/kjell.24..202407.660

Kic-Drgas, J., Woźniak, J., Bocanegra-Valle, A., John, P., & Mertelj, D. (2024). Discrepancies between the institutionally offered special language teaching and the needs of special language teachers. A methodological approach. *Linguistic meetings in Wrocław, (24)*, 103-116. https://www.ceeol.com/search/article-detail?id=1225283

Kuhna, R. (2019). *Taking into account the national curriculum in Finnish French textbooks for primary education* (Master's thesis). University of Jyväskylä. https://jyx.jyu.fi/handle/123456789/63358

Kukulska-Hulme, A., Friend Wise, A., Coughlan, T., Biswas, G., Bossu, C., Burriss, S. K., ... & Whitelock, D. (2024). Innovating Pedagogy 2024. The Open University. https://oro.open.ac.uk/99053/

Leleka, V., Ketsyk-Zinchenko, U., Petrenko, N., Potapchuk, N., & Syroiezhko, O. (2024). Innovative technologies for healthy education: a practical guide for educational institutions. *Amazonia Investiga*, *13*(81), 214–233. https://doi.org/10.34069/ai/2024.81.09.17

Li, D., & Zhang, L. (2022). Exploring teacher scaffolding in a CLIL-framed EFL intensive reading class: A classroom discourse analysis approach. *Language Teaching Research*, *26*(3), 333-360. https://doi.org/10.1177/1362168820903340

Marsh, D., & Pérez, W. D. (2024). Realising interdisciplinary learning environments through CLIL. In *Transnational Approaches to Bilingual and Second Language Teacher Education* (pp. 15-32). Routledge. https://doi.org/10.1002/9781405198431.wbeal0190.pub2

Martens, L., Mettewie, L., & Elen, J. (2023). Looking for the i in CLIL: A literature review on the implementation of dual focus in both subject and language classrooms. *Nordic Journal of Language Teaching and Learning*, *11*(3), 255-277. https://doi.org/10.46364/njltl.v11i3.1155

Merchán Cedillo, M. B., & Mora Aguilar, L. F. (2024). *The use of clil methodology to improve the English vocabulary of students* (Bachelor's thesis), Machala: Universidad Técnica de Machala. https://repositorio.utmachala.edu.ec/handle/48000/22832

Morgado, M., Gómez, L. V., & Calvete, M. (2019). Aprender (n) uma língua estrangeira no ensino superior: perceções de empregadores e alunos. *Millenium-Journal of Education, Technology, and Health*, (4e), 81-89. https://revistas.rcaap.pt/millenium/article/view/18037

Myronenko, T., Dobrovolska, L., Shevchenko, I., & Kordyuk, O. (2024). Challenges and sustainability of CLIL implementation in Ukrainian educational institutions. *Amazonia Investiga*, *13*(77), 53-65. https://doi.org/10.34069/AI/2024.77.05.4

Navarro Henares, T. (2020). *The effectiveness of gamification tools to teach and learn EFL: A survey-based study on L1 Spanish-Catalan secondary school students* (Master's thesis). University of the Balearic Islands, Centre for Postgraduate Studies. http://surl.li/oexzhq

Nikula, T., Dalton-Puffer, C., Llinares, A., & Lorenzo, F. (2016). More than content and language: The complexity of integration in CLIL and bilingual education. *Conceptualising integration in CLIL and multilingual education*, *101*(1). https://doi.org/10.21832/9781783096145-004

O'Connell, A. M., & Chaplier, C. (2021). Les langues de spécialité dans l'enseignement supérieur en France: un exemple de littératie enseignante dans le domaine de l'anglais des sciences. *Education & didactique*, 85-102. https://shs.cairn.info/revue-education-et-didactique-2021-2-page-85?lang=fr

Papaja, K. (2023). Content and Language Integrated Lerning (CLIL) in European Higher Education. *Multidisciplinary Journal of School Education*, *12*(1). https://doi.org/10.35765/mjse.2023.1223.11

Paran, A. (2013). CLIL: Content and Language Integrated Learning. *ELT Journal, 67*(1), 137–141. https://academic.oup.com/eltj/article-abstract/67/1/137/438609

Paweloszek, I., Kumar, N., & Solanki, U. (2022). Artificial Intelligence, Digital Technologies and the Future of Law: Literature Review. *Futurity Economics&Law*, *2*(2), 35–53. https://doi.org/10.57125/FEL.2022.06.25.03

Petit, K. (2020). *Immersed in "Authentic Ireland": A Critical Sociolinguistic Study of the Revitalization of Irish in Language Stays* (Doctoral dissertation), Université de Lyon. https://theses.hal.science/tel-03130731/

Porcedda, M. E., & González-Martínez, J. (2020). CLIL teacher training: Gaps and suggestions from a systematic literature review. *Enseñanza & Teaching*, *38*(1), 49-68. https://www.torrossa.com/en/resources/an/5010995#page=51

Porto, M. (2021). Intercultural citizenship in foreign language education: An opportunity to broaden CLIL's theoretical outlook and pedagogy. *International Journal of Bilingual Education and Bilingualism*. https://doi.org/10.1080/13670050.2018.1526886

Radziievska, I., Trepet, G., Radzikhovska, N., Sukhostavets, N., Yuryk, O., & Saienko, V. (2022). Modern achievements and prospects for the development of higher medical education: Ukrainian realities. *Amazonia Investiga*, *11*(55), 114–123. https://doi.org/10.34069/ai/2022.55.07.12

Rebolo Roca, J. (2021). *Boosting students' engagement in the EFL classroom with classic and the latest ICT tools* (Master's thesis). University of the Balearic Islands, Centre for Postgraduate Studies.

Şentürk, C. (2021). Effects of the blended learning model on preservice teachers' academic achievements and twenty-first century skills. *Education and Information Technologies*, *26*(1), 35-48. https://link.springer.com/article/10.1007/s10639-020-10340-y

Settelmeyer, A., Münchhausen, G., & Schneider, K. (2019). *Integrated learning of language and subject in the career orientation and career preparation of refugees: scientific expertise on the program "Career Orientation for Refugees"* (BOF): Duration: May 2018 to December 2018 (No. 207). Scientific discussion papers. https://www.econstor.eu/handle/10419/236171

Silva, J. H. A. da. (2022). A abordagem AICLE/CLIL e as TICs na formação docente: aplicações didáticas. *Ensino em Perspectivas*, *3*(1), 1-11. https://revistas.uece.br/index.php/ensinoemperspectivas/article/view/9000

Štefková, J., & Danihelová, Z. (2023). CA-CLIL: Teachers' and students' perceptions of implementing clil in tertiary education. *Advanced Education*, 137-151. https://ae.fl.kpi.ua/article/view/283210

Tinedo Rodríguez, A. J. (2022). Producción fílmica, género, literatura y traducción audiovisual didáctica (TAD) para el aprendizaje integrado de contenidos y lenguas (AICLE). *Digilec: revista internacional de lenguas y culturas*, *9*, 140-161. https://doi.org/10.17979/digilec.2022.9.0.9155

Vonitsanos, G., Moustaka, I., Doukakis, S., & Mylonas, P. (2024, May). Transforming Education in the Digital Age: Exploring the Dimensions of Education 4.0. In *2024 IEEE Global Engineering Education Conference (EDUCON)* (pp. 01-10). IEEE. https://doi.org/10.1109/EDUCON60312.2024.10578747

Waloyo, A. A., Khoiriyah, K., & Farah, R. R. (2021). Teachers' perception to clil and web-based material implementation in a primary school. *English Review: Journal of English Education, 9*(2), 227-234. https://doi.org/10.25134/erjee.v9i2.4347

Yuhan, N. L. (2017). Multimedia technologies of teaching "Russian language" to foreign students at the initial stage. *Science and Education, (5),* 27-32. http://dspace.pdpu.edu.ua/handle/123456789/923

Zainuddin, Z., Chu, S. K. W., & Perera, C. J. (2024). Gamification Platforms for Flipped Learning Implementation. In *Gamification in A Flipped Classroom: Pedagogical Methods and Best Practices* (pp. 167-180). Singapore: Springer Nature Singapore. https://link.springer.com/chapter/10.1007/978-981-97-2219-8_5

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.8
Cómo citar:
Byhar, H., Pits, I., Shevchuk, K., Shestobuz, O., & Hordiichuk, O. (2024). Formation of critical thinking in junior schoolchildren through problem-based tasks. *Revista Eduweb*, *18*(4), 121-131. https://doi.org/10.46502/issn.1856-7576/2024.18.04.8

Formation of critical thinking in junior schoolchildren through problem-based tasks

Formación de pensamiento crítico en los alumnos de primaria mediante tareas basadas en problemas

Hanna Byhar
https://orcid.org/0000-0001-8373-463X
hannabyhar@gmail.com
Ph.D. Candidate of Pedagogical Sciences, Associate Professor, Department of Pedagogy and Methods of Primary Education, Yuriy Fedkovych Chernivtsi National University, Chernivtsi Ukraine.
Iryna Pits
https://orcid.org/0000-0002-7911-9922
irynap@gmail.com
Ph.D. Candidate of Pedagogical Sciences, Associate Professor, Department of Pedagogy and Methods of Primary Education, Yuriy Fedkovych Chernivtsi National University, Chernivtsi Ukraine.
Krystyna Shevchuk
https://orcid.org/0000-0002-9365-1456
krystynash@gmail.com
Ph.D. Candidate of Pedagogical Sciences, Associate Professor, Department of Pedagogy and Methods of Primary Education, Yuriy Fedkovych Chernivtsi National University, Chernivtsi Ukraine.
Olha Shestobuz
https://orcid.org/0000-0001-7268-8316
olha.shestozub@gmail.com
Ph.D. Candidate of Pedagogical Sciences, Associate Professor, Department of Pedagogy and Methods of Primary Education, Yuriy Fedkovych Chernivtsi National University, Chernivtsi Ukraine.
Oksana Hordiichuk
https://orcid.org/0000-0002-3298-9533
oksana.hord@gmail.com
Ph.D. Candidate of Pedagogical Sciences, Associate Professor, Department of Pedagogy and Methods of Primary Education, Yuriy Fedkovych Chernivtsi National University, Chernivtsi Ukraine.

Recibido: 08/10/24
Aceptado: 21/12/24

Abstract

The development of critical thinking is an essential component of modern education. This study aimed to identify the impact of problem-based tasks on developing critical thinking in primary school students. The research methods included Watson-Glaser testing, Cornell Critical Thinking Test (level X), ANOVA and correlation analysis. The results showed a significant improvement in the experimental group: in the category “Identifying Facts”, the average score increased from 3.5 to 5.5, in “Interpreting Data” - from 4.0 to 6.0, and in “Drawing Conclusions” - from 3.0 to 5.0. Also, in the “Situation Analysis” category, the score

increased from 3.2 to 5.3, and in “Hypothesis Formulation”, from 2.8 to 4.7. The final score of the experimental group increased from 12.3 to 16.5, while the control group showed only a slight improvement (from 11.8 to 12.0), confirming the effectiveness of problem-based tasks. The practical significance of the results in introducing problem-based tasks to develop students' critical skills makes the study's findings applicable and valuable. Prospects for further research include the study of long-term effects and the impact of socio-economic factors on the effectiveness of these methods.

Keywords: analysis, cognitive skills, critical thinking, educational process, primary school students, problem-based tasks, reflection.

Resumen

El desarrollo del pensamiento crítico es un componente esencial de la educación moderna. El objetivo de este estudio fue identificar el impacto de las tareas basadas en problemas sobre el desarrollo del pensamiento crítico en los alumnos de primaria. Los métodos de investigación incluyeron pruebas de Watson-Glaser, prueba de pensamiento crítico de Cornell (nivel X), análisis de varianza y análisis de correlación. Los resultados mostraron una mejora significativa en el grupo experimental: en la categoría "Identificar hechos" la puntuación media aumentó de 3,5 a 5,5, en "Interpretar datos" - de 4,0 a 6,0 y en "Extraer conclusiones" - de 3,0 a 5,0. También en la categoría "Análisis de situación" el puntaje aumentó de 3,2 a 5,3, y en "Formulación de hipótesis", de 2,8 a 4,7. La puntuación final del grupo experimental aumentó de 12,3 a 16,5, mientras que el grupo control mostró solo una ligera mejora (de 11,8 a 12,0), confirmando la efectividad de las tareas basadas en problemas. La importancia práctica de los resultados en la introducción de tareas basadas en problemas para desarrollar las habilidades críticas de los estudiantes hace que los hallazgos del estudio sean aplicables y valiosos. Las perspectivas de investigación futura incluyen el estudio de los efectos a largo plazo y la repercusión de los factores socio económicos en la eficacia de estos métodos.

Palabras clave: análisis, competencias cognitivas, pensamiento crítico, proceso educativo, alumnos de primaria, tareas basadas en problemas, reflexión.

Introduction

Developing critical thinking in primary school students is a pivotal task of modern education. The ability to analyse information, ask questions, draw reasonable conclusions, and find solutions to complex problems is crucial in preparing students for their future lives. In the learning process, critical thinking helps children acquire knowledge and actively use it to solve real problems. This emphasis on critical thinking in the learning process is a crucial aspect of modern education, as highlighted by the research of Polat and Aydın (2020).

Problem-based tasks, as a pedagogical tool, hold immense potential for developing critical thinking in primary school children (Liu & Pásztor, 2022). They stimulate students to think logically, analyse different aspects of tasks, seek alternative solutions, and cultivate the ability to self-evaluate their actions (Fidan & Tuncel, 2019). Students can explore new problem-solving approaches by engaging in problem-based tasks, stimulating their cognitive activity (Duda, Susilo & Newcombe, 2019). This potential offers a hopeful outlook for the future of education.

The relevance of studying the issue of critical thinking in primary school is also due to modern educational requirements that focus on fostering innovative approaches to learning. Traditional methods often do not allow children to develop the critical analysis and reflection skills necessary for successful socialisation in modern society (O'Reilly, Devitt & Hayes, 2022). Therefore, the issue of integrating problem-based learning into the educational process is critical.

In addition, developing critical thinking through problem-based tasks effectively increases students' motivation to study (Saputra et al., 2019). Students' interest in learning increases when they face real-world problems that they must solve independently or in groups. This form of work contributes to developing not only thinking skills but also communication and social skills, which are extremely important for the harmonious development of the individual (Seibert, 2021). Thus, developing critical thinking in primary school students through problem-based tasks is a relevant and promising area in modern pedagogy. This process requires careful study and improvement of methodological approaches to ensure learning effectiveness and the development of the necessary competencies in children.

Despite a large number of studies, the question of the effectiveness of specific methods, particularly problem-based learning, remains open. There are different approaches to developing critical thinking, but not all are fully adapted to younger students' age and psychological characteristics. This creates the need for a detailed study of how problem-based tasks can be integrated into the curriculum to maximise the development of students' analytical and reflective abilities. Modern educational practice demonstrates various ways to use problem-based tasks. Still, finding the most effective forms and presentation methods is necessary to achieve optimal results.

The study aims to identify the impact of problem-based tasks on developing critical thinking in junior schoolchildren. Objectives of the study:

1. Determine the level of critical thinking development in primary school students before and after using problem-based tasks.
2. Analyse the impact of problem-based tasks on developing critical thinking components such as analysis, synthesis, evaluation, and reflection.
3. To empirically test the effectiveness of different types of problem-based tasks in the learning process of junior pupils.
4. To identify the relationship between the level of students' involvement in problem-based task solving and changes in cognitive and reflective abilities.

Literature review

Researchers worldwide have studied the peculiarities of critical thinking in primary school students to find effective teaching methods that promote the development of analytical and reflective skills. These studies identify the relationships between different pedagogical approaches and learning outcomes. The survey by Bezanilla et al. examined how different teaching methods affect the development of critical thinking in higher education students (Bezanilla et al., 2019). The authors focused on the effectiveness of active learning and the role of the teacher as a facilitator of the process. Ramadhani et al. found that using a flipped learning model integrated with the Google Classroom LMS positively impacted high school students' academic performance (Ramadhani et al., 2019). Students who participated in such learning demonstrated higher results in solving problem-based tasks.

Jensen et al. have shown that an interdisciplinary approach to problem-based learning promotes a deeper understanding of topics and improves students' critical thinking (Jensen et al., 2019). The study notes that collaboration between disciplines stimulates students' interest in learning. In addition, Sari et al. (2021) found that using mind mapping in inquisitorial learning significantly increases students' critical thinking skills and motivation. This suggests that visualising information helps students to structure their knowledge better. Guo et al. reviewed project-based learning in higher education and noted that it improves learning outcomes and develops students' key competencies (Guo et al., 2020). The authors highlight the importance of assessing learning outcomes to enhance methods further. In addition, Al Mamun et al. investigated how the design of supported learning modules in an online environment affects self-organisation and requested learning (Al Mamun et al., 2020). The results showed that structuring the material contributes to better student learning.

Supena et al. found that the 4Cs (Constructive, Critical, Creative, Collaborative) learning model improves student learning outcomes (Supena et al., 2020). The application of this model increases students' activity and interest in the learning process. Almulla has shown that a project-based learning approach actively engages students in learning (Almulla, 2020). Students who participated in project-based learning reported increased motivation and interest. Ren et al. found that critical thinking is a powerful predictor of academic performance in children and adults, outperforming general cognitive ability (Ren et al., 2020). This indicates the importance of developing critical thinking as a separate skill to improve learning outcomes. Chinese researcher Wu has shown that using philosophy to teach children positively impacts students' critical thinking (Wu, 2021). The results of a pilot study show an increase in students' analytical skills, confirming this approach's effectiveness.

Lombardi et al. found that primary school teachers have positive experiences using strategies that promote students' critical thinking (Lombardi et al., 2024). Respondents noted that such teaching methods increase children's interest and improve their analytical skills. In another study, Lombardi et al. emphasised that integrating critical thinking into the primary school curriculum is essential in developing this skill in students (Lombardi et al., 2021). A systematic approach to teaching essential thinking improves European schools' overall quality of education. Blyznyuk and Kachak (2024) noted that interactive learning significantly enhances students' critical thinking skills. The study confirmed that active participation in the learning process stimulates the development of student's analytical thinking and creativity.

In analysing the results of previous studies on the development of critical thinking in primary school students, several contradictions and unexplored aspects were identified. Firstly, despite the general recognition of the importance of critical thinking, there is a lack of practical recommendations on integrating effective methods into the educational process. Secondly, the variety of approaches to assessing learning effectiveness creates difficulties in generalising the results. In addition, the lack of a unified approach to defining the components of critical thinking in primary school students leaves open questions about its structure and development. This suggests the need for a more in-depth study of the topic to identify optimal strategies and methods contributing to this critical competence.

Methods and materials

The research procedure

The study was implemented according to an experimental design, in which two classes participated - experimental and control. The first stage involved preliminary monitoring of students' critical thinking levels in both classes using standardised tests. After that, for three months, the experimental class was introduced to problem-based tasks designed to meet the age-specific needs of the students. At the same time, the control class continued to use traditional teaching methods. In the second stage, after the end of the implementation, the students' critical thinking was reassessed using similar tests. In the third stage, the collected data was analysed using statistical methods, which allowed us to assess the effectiveness of the implemented strategies.

Sample

The study was conducted from January to June 2024 in three primary schools in Kyiv (Novopecherska School, Kyivo-Pecherskiy Lyceum #171 “Leader”, Liko-School). The schools were selected based on their readiness to implement innovative teaching methods. The study involved 120 primary school students. The respondents ranged from 8 to 10 years old, corresponding to pupils in grades 3-4. The gender distribution of participants was approximately equal: 58 girls and 62 boys. This age group was chosen because children actively develop cognitive skills and the ability to think analytically during this period. This is important for studying the formation of critical thinking through problem-based learning. The sample was formed based on voluntary participation; pupils were randomly selected from classes that expressed their willingness to join the experiment. Participants were randomly assigned to classes. A team of researchers conducted the

selection under the guidance of teachers and with the participation of a school psychologist. Before the study began, written parental consent was obtained to allow children to participate, confirming their voluntary participation. The school psychologist was present during all stages of the survey to ensure the emotional comfort of the children and prevent possible stressful situations.

Research methods

The study used several empirical methods to assess the development of critical thinking in primary school children. The main testing tool was the *Watson-Glaser Critical Thinking Appraisal*, adapted for children aged 8-10 (Watson & Glaser, 2020). It allowed us to assess students' ability to analyse arguments, draw logical conclusions and recognise assumptions. The *Cornell Critical Thinking Test* (level X) included tasks aimed at assessing the skills of analysing, classifying and interpreting information (Hasinger, 2024), while the *Torrance Tests of Creative Thinking* (TTCT) was used to study the creative component of thinking, which allowed us to assess students' ability to generate new ideas and find alternative solutions (Torrance, 2022).

In addition to testing, observing students while performing problem-based tasks was used to record their behavioural manifestations of critical thinking. To increase the reliability of the results, a pedagogical experiment was conducted, which involved dividing students into control and experimental groups, which made it possible to compare the effectiveness of different approaches to teaching critical thinking.

Statistical analysis

Statistical methods were used to process the data and evaluate the study results. The primary tool for analysing quantitative data was the SPSS (Statistical Package for the Social Sciences) software, version 26.0, which allowed for accurate calculations and interpretation of the results. Initially, *descriptive statistics* was used to determine the leading indicators, such as means, medians, modes, and standard deviations. To test the hypotheses and assess the significance of differences between the control and experimental groups, *the Independent Samples t-test* was applied, which allowed the comparison of the average values before and after the experiment.

In addition, Analysis of Variance ANOVA was used to assess the impact of various factors (age, gender, study group) on test results. Spearman's correlation analysis was also conducted to identify relationships between levels of critical thinking and other indicators.

Results

Table 1 presents the results of the Watson-Glaser Critical Thinking Appraisal with t-test data and corresponding p-values for the experimental and control groups.

Table 1.
The results of the assessment of critical thinking using the Watson-Glaser Critical Thinking Appraisal methodology

Question	Experimental group (before)	Experimental group (after)	Control group (before)	Control group (after)	t-value	p-value
Determining the facts	3,5	5,5	3,3	3,6	4,23	< 0,001
Data interpretation	4,0	6,0	3,5	4,0	5,12	< 0,001
Evaluation of arguments	4,8	5,0	4,0	4,2	1,68	0,098
Definition of conclusions	3,0	5,0	2,5	3,0	4,76	< 0,001
Situation analysis	3,2	5,3	3,0	3,5	3,89	< 0,001
Formulation of hypotheses	2,8	4,7	2,9	3,2	4,54	< 0,001
Identifying biases	3,1	4,8	3,4	3,6	3,21	0,002
Determining cause and effect relationships	4,5	6,5	4,0	4,1	4,92	< 0,001
Total score	12,3	16,5	11,8	12,0	5,84	< 0,001

Source: developed by the author based on collected data on the participants of the experiment

The data presented in the table shows a significant improvement in the level of critical thinking of students in the experimental group after the introduction of problem-based tasks. According to the Watson-Glaser methodology, all assessment categories showed an increase in scores, which indicates the positive impact of this approach on the development of critical skills. For example, in the category “Identifying Facts”, the average score of the experimental group increased from 3.5 to 5.5, which indicates an improvement in students' ability to recognise facts among information noise. The control group only slightly increased their score (3.3 to 3.6), confirming minimal improvement without active learning. A similar trend is observed in other categories. For example, in “Interpreting Data”, the experimental group rose from 4.0 to 6.0, while the control group slightly increased from 3.5 to 4.0. In the category “Drawing Conclusions”, the average score of the experimental group increased from 3.0 to 5.0, demonstrating a significant improvement in the ability to draw reasonable conclusions.

The data also shows progress in the “Situation Analysis” category, where the experimental group improved their score from 3.2 to 5.3. The control group's score remained virtually unchanged (from 3.0 to 3.5). Similar results are observed in the “Hypothesis Formulation” category, where the experimental group increased from 2.8 to 4.7, while the control group improved slightly (from 2.9 to 3.2). In general, the experimental group showed a significant improvement in all measured aspects of critical thinking, which confirms the hypothesis of the effectiveness of problem-based learning. The final score of the experimental group increased from 12.3 to 16.5, while the control group showed minimal improvement (from 11.8 to 12.0). These results indicate that using problem-based tasks in the educational process can be important for developing critical thinking in primary school students.

Table 2 shows the results of assessing the impact of problem-based learning on the development of critical thinking components according to the Cornell Critical Thinking Test (level X).

Table 2.
Results of the evaluation of the impact of problem-based tasks on the development of critical thinking components according to the Cornell Critical Thinking Test

Components of critical thinking	Experimental group (before)	Experimental group (after)	Control group (before)	Control group (after)	F-value	p-value
Analysis	12,1	17,4	12,0	12,3	9,12	< 0,001
Synthesis	11,5	16,0	11,2	11,5	8,23	< 0,001
Assessment	10,8	15,2	10,6	10,9	8,45	0,098
Reflection	9,4	14,1	9,2	9,5	7,12	< 0,001

Source: developed by the author based on collected data on the participants of the experiment

The test results showed that the students who participated in the problem-based tasks demonstrated significant improvements in all the assessed components of critical thinking. For example, in the category of “Analysis”, the average score of the experimental group increased from 12.1 to 17.4, which indicates the effective development of skills in recognising structures and patterns in information. In the control group, the average score remained virtually unchanged (from 12.0 to 12.3), which confirms the lack of significant progress without active teaching methods.

A similar increase was observed in the “Synthesis” category: the experimental group increased its score from 11.5 to 16.0, while the control group remained at 11.2-11.5. This indicates that problem-based tasks contribute to developing skills in integrating information and generating new ideas. As for the “Assessment” category, the average score of the experimental group increased from 10.8 to 15.2, while the control group showed minimal changes (from 10.6 to 10.9). The results of ANOVA confirmed the statistical significance of these changes ($F(1, 58) = 8.45$, $p < 0.001$), which indicates a positive impact of problem-based tasks on the development of assessment skills. Finally, in the “Reflection” category, the experimental group increased from 9.4 to 14.1. The control group, in turn, showed a slight change (from 9.2 to 9.5). ANOVA also indicated the significance of these changes ($F(1, 58) = 7.12$, $p < 0.01$), confirming that problem-based tasks contribute to the development of reflective thinking. Thus, the study's results demonstrate that

problem-based tasks significantly positively impact the development of critical thinking components, including analysis, synthesis, assessment and reflection. Fig. 1 shows the performance levels of problem-based tasks among junior pupils by type of task: creative problem-solving, logical connections, self-analysis and self-control. Percentages are presented for high, medium and low levels of task performance.

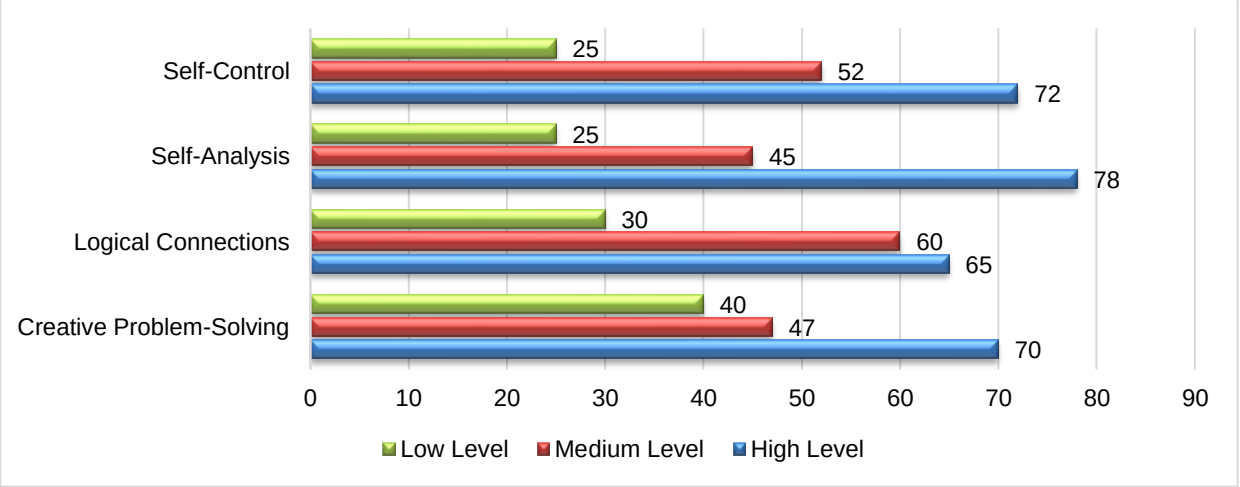

Figure 1. Levels of poblem-solving among primary school pupils.
Source: developed by the author based on collected data on the participants of the experiment.

The chart analysis shows that students from the high-achieving group demonstrate the highest results in problem-based tasks. This indicates that these students have well-developed critical thinking and reflection skills. Middle-level students perform more moderately, including better results in functions that analyse logical connections (60%) and self-control (52%). However, they demonstrate weaker synthesis and self-analysis skills than high-level students, indicating a need to develop these abilities further. Significant difficulties in completing tasks characterise the low level of performance, especially those requiring analysis and synthesis of information, such as self-analysis tasks (25%) and self-control tasks (25%). This indicates that these students have insufficient cognitive and reflective abilities, significantly complicating solving problematic tasks. Table 3 shows the results of the correlation analysis, which demonstrates the relationship between the level of students' involvement in solving complex tasks and changes in abilities.

Table 3.
Spearman's Rank Correlation analysis between the level of students' involvement in problem-solving and changes in their cognitive and reflective abilities

Ability type	Indicators	Involvement level (ρ)	p-value
Cognitive abilities	Attention	0,70	< 0,001
	Perception	0,65	< 0,01
	Thinking	0,73	< 0,001
	Memory	0,67	< 0,01
Reflective abilities	Self-awareness	0,66	< 0,01
	Self-analysis	0,71	< 0,001
	Self-analysis	0,68	< 0,01
	Self-control	0,64	< 0,01
	Reflection on the learning process	0,69	< 0,01
	Emotional reflection	0,62	< 0,01

Source: developed by the author based on collected data on the participants of the experiment

The analysis of Table 3 shows that students' involvement in problem-solving positively correlates with developing their cognitive abilities. The most vital relationship is observed between the level of engagement and improved thinking ($\rho = 0.73$, $p < 0.001$). This indicates a significant impact of active problem-solving on students' ability to analyse and process information. Significant correlations are also noted for attention and memory. This confirms the effect of interactive learning on improving basic cognitive processes.

In reflective abilities, the highest correlation was found with self-analysis ($\rho = 0.71$, $p < 0.001$). This indicates the importance of problem-based tasks for students' ability to analyse their actions and the reasons for their successes or failures. A high level of engagement also had a significant impact on the development of self-esteem ($\rho = 0.68$, $p < 0.01$) and reflection on the learning process ($\rho = 0.69$, $p < 0.01$). This indicates an increase in the ability of students to recognise the effectiveness of their teaching methods and approaches.

Discussion

The results of our study confirm the findings of Amin et al. (2020), who found that problem-based learning significantly improves students' critical thinking and environmental awareness. This indicates the versatility of the effectiveness of this approach, which contributes to the development of various aspects of essential skills. Thorndahl and Stentoft (2020) emphasise the importance of critical thinking in the context of higher education. This aligns with our results, as problem-based tasks stimulate deeper thinking and analysis of information. This parallel confirms that problem-based learning is an effective means of preparing students for complex tasks.

Ahdhianto et al. (2020) demonstrated that problem-based learning improves fifth graders' mathematical problem-solving and critical thinking. This aligns with our results, where students in the experimental group also showed significant improvements in critical skills through problem-based learning. In their systematic review, Anggraeni et al. (2023) emphasise that problem-based learning promotes critical thinking in students of all ages. Our findings support this view, showing that primary school students engaged in problem-based learning significantly improved their skills.

Razak et al. (2022) also found that introducing problem-based learning into the educational process improves critical thinking. This reflects the results of our study, where the experimental group demonstrated significant improvements in necessary skills. The survey by Manuaba et al. (2022) explains the effectiveness of problem-based learning in medical education, emphasising its role in developing independent learning and critical thinking. Similarly, our study shows that younger students can benefit from an active learning approach. Yusuf et al. (2020) showed that problem-based learning based on LBK increases critical thinking and learning outcomes. Our findings confirm that similar methods can be successfully adapted for younger students, contributing to their development of essential skills. The practical application of the results is integrating problem-based tasks into the learning process to develop critical thinking in primary school students. This will improve their learning outcomes and contribute to the formation of critical cognitive skills necessary for further learning and personal development.

Limitations of the study

The study's limitations include its conduct within a single city, which limits the generalisability of the results, and using only one type of test to assess critical thinking. In addition, the short implementation of the problem-based learning tasks limits the ability to identify long-term effects, and the lack of control over external factors such as social conditions may have influenced the results.

Recommendations

Introducing problem-based tasks into the learning process is recommended as an effective tool for developing students' critical thinking. It is essential to train teachers on how to use such tasks. In addition,

the effectiveness of the implemented methods should be regularly evaluated to adapt the curriculum to the needs of students.

Conclusions

The development of critical thinking in primary school students is an essential aspect of modern education, as it contributes to the successful learning process. The study's results indicate a significant positive impact of problem-based learning on developing critical thinking in primary school students. The study showed that the experimental group demonstrated significant improvement in all measured aspects of critical thinking, confirming this approach's effectiveness. In particular, students in the experimental group made substantial gains in the categories assessed by the Watson-Glaser methodology, including “Identifying Facts”, “Interpreting Data”, “Drawing Conclusions”, and “Analysing Situations”. The average score of the experimental group increased from 12.3 to 16.5, indicating a significant improvement in their critical skills, while the control group showed slight improvement. This result suggests that without active learning, students' progress remains minimal. The results also confirm that students who were actively involved in solving problematic tasks improved their skills in the categories of “Analysis”, “Synthesis”, “Assessment”, and “Reflection”. Statistical analysis showed that these changes are significant, which emphasises the importance of problem-based learning in the educational process. In addition, the correlation analysis revealed that a high level of students' involvement in problem-based learning is positively correlated with developing their cognitive and reflective abilities. This confirms that active learning improves basic mental processes such as attention, memory and self-analysis. Thus, the study results emphasise the importance of problem-based learning as an essential tool for developing critical thinking in younger students. Introducing such tasks into the learning process can significantly improve the quality of education and encourage students to analyse and reflect more deeply, which will help to develop their critical skills. Areas for future research could include studying the long-term effects of introducing problem-based learning on the development of student's critical thinking in different age groups and educational contexts. It is also essential to study the impact of socioeconomic factors on the effectiveness of such teaching methods.

Bibliographic references

Ahdhianto, E., Marsigit, H., & Nurfauzi, Y. (2020). Improving fifth-grade students’ mathematical problem-solving and critical thinking skills using problem-based learning. *Universal Journal of Educational Research, 8*(5), 2012-2021. https://doi.org/10.13189/ujer.2020.080539

Al Mamun, M. A., Lawrie, G., & Wright, T. (2020). Instructional design of scaffolded online learning modules for self-directed and inquiry-based learning environments. *Computers & Education*, *144*, 103695. https://doi.org/10.1016/j.compedu.2019.103695

Almulla, M. A. (2020). The effectiveness of the project-based learning (PBL) approach as a way to engage students in learning. *Sage Open, 10*(3), 1-15. https://doi.org/10.1177/2158244020938702

Amin, S., Utaya, S., Bachri, S., Sumarmi, S., & Susilo, S. (2020). Effect of problem based learning on critical thinking skill and enviromental attitude. *Journal for the Education of Gifted Young Scientists, 8*(2), 743-755. https://doi.org/10.17478/jegys.650344

Anggraeni, D. M., Prahani, B. K., Suprapto, N., Shofiyah, N., & Jatmiko, B. (2023). Systematic review of problem based learning research in fostering critical thinking skills. *Thinking Skills and Creativity*, *49*, 101334. https://doi.org/10.1016/j.tsc.2023.101334

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher’s view. *Thinking skills and creativity*, *33*, 100584. https://doi.org/10.1016/j.tsc.2019.100584

Blyznyuk, T., & Kachak, T. (2024). Benefits of interactive learning for students' critical thinking skills improvement. *Journal of Vasyl Stefanyk Precarpathian National University, 11*(1), 94-102.

Chashechnikova, O., Odintsova, O., Hordiienko, I., Danylchuk, O., & Popova, L. (2024). Innovative technologies for the development of critical thinking in students. *Amazonia Investiga*, *13*(81), 197–213. https://doi.org/10.34069/AI/2024.81.09.16

Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction, 12*(1), 1207-1222. https://files.eric.ed.gov/fulltext/EJ1201323.pdf

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem-based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, *142*, 103635. https://doi.org/10.1016/j.compedu.2019.103635

Folomieieva, N., Koriakin, O., Matsenko, L., Siaska I., & Fed, I. (2024). Problem-based learning in higher education: a path towards training innovative and competent specialists. *Amazonia Investiga*, *13*(77), 201–217. https://doi.org/10.34069/AI/2024.77.05.15

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, *102*, 101586. https://doi.org/10.1016/j.ijer.2020.101586

Hasinger, E. (2024). *Cornell Critical Thinking Test Guid*. Tests.com. Retrived from https://acortar.link/V6cdoP

Jensen, A. A., Stentoft, D., & Ravn, O. (2019). *Interdisciplinarity and problem-based learning in higher education*. Cham: Springer. https://doi.org/10.1007/978-3-030-18842-9

Liu, Y., & Pásztor, A. (2022). Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*, *45*, 101069. https://doi.org/10.1016/j.tsc.2022.101069

Lombardi, L., Thomas, V., Rodeyns, J., Mednick, F. J., De Backer, F., & Lombaerts, K. (2024). Primary school teachers' experiences of teaching strategies that promote pupils' critical thinking. *Educational Studies, 50*(5), 683-701. https://doi.org/10.1080/03055698.2021.1990017

Lombardi, L., Mednick, F. J., De Backer, F., & Lombaerts, K. (2021). Fostering critical thinking across the primary school's curriculum in the European schools system. *Education Sciences, 11*(9), 505. https://doi.org/10.3390/educsci11090505

Manuaba, I. B. A. P., -No, Y., & Wu, C. C. (2022). The effectiveness of problem based learning in improving critical thinking, problem-solving and self-directed learning in first-year medical students: A meta-analysis. *PloS One, 17*(11), 0277339. https://doi.org/10.1371/journal.pone.0277339

O'Reilly, C., Devitt, A., & Hayes, N. (2022). Critical thinking in the preschool classroom – A systematic literature review. *Thinking skills and creativity*, *46*, 101110. https://doi.org/10.1016/j.tsc.2022.101110

Polat, Ö., & Aydın, E. (2020). The effect of mind mapping on young children's critical thinking skills. *Thinking Skills and Creativity*, *38*, 100743. https://doi.org/10.1016/j.tsc.2020.100743

Ramadhani, R., Umam, R., Abdurrahman, A., & Syazali, M. (2019). The effect of flipped-problem based learning model integrated with LMS-google classroom for senior high school students. *Journal for the Education of Gifted Young Scientists, 7*(2), 137-158. https://doi.org/10.17478/jegys.548350

Razak, A. A., Ramdan, M. R., Mahjom, N., Zabit, M. N. M., Muhammad, F., Hussin, M. Y. M., & Abdullah, N. L. (2022). Improving critical thinking skills in teaching through problem-based learning for students: A scoping review. *International Journal of Learning, Teaching and Educational Research, 21*(2), 342-362. https://doi.org/10.26803/ijlter.21.2.19

Ren, X., Tong, Y., Peng, P., & Wang, T. (2020). Critical thinking predicts academic performance beyond general cognitive ability: Evidence from adults and children. *Intelligence*, *82*, 101487. https://doi.org/10.1016/j.intell.2020.101487

Saputra, M. D., Joyoatmojo, S., Wardani, D. K., & Sangka, K. B. (2019). Developing critical-thinking skills through the collaboration of a jigsaw model with a problem-based learning model. *International Journal of Instruction, 12*(1), 1077-1094. https://files.eric.ed.gov/fulltext/EJ1201249.pdf

Sari, R., Sumarmi, S., Astina, I., Utomo, D., & Ridhwan, R. (2021). Increasing students' critical thinking skills and learning motivation using inquiry mind map. *International Journal of Emerging Technologies in Learning (iJET), 16*(03), 4-19. https://doi.org/10.3991/ijet.v16i03.16515

Seibert, S. A. (2021). Problem-based learning: A strategy to foster Generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing, 16*(1), 85-88. https://doi.org/10.1016/j.teln.2020.09.002

Supena, I., Darmuki, A., & Hariyadi, A. (2020). The influence of 4C (constructive, critical, creativity, collaborative) learning model on students' learning outcomes. *International Journal of Instruction, 14*(3), 873-892. https://doi.org/10.29333/iji.2021.14351a

Thorndahl, K. L., & Stentoft, D. (2020). Thinking critically about critical thinking and problem-based learning in higher education: A scoping review. *Interdisciplinary Journal of Problem-Based Learning, 14*(1). https://doi.org/10.14434/ijpbl.v14i1.28773

Torrance, E. P. (2022). *Torrance Tests of Creative Thinking (TTCT)*. Testingmom. Retrived from https://www.testingmom.com/tests/torrance-test/

Watson, G., & Glaser, E. (2020). *Watson-Glaser Critical Thinking Appraisal*. Pearson. Retrived from https://www.talentlens.com/content/dam/school/global/Global-Talentlens/uk/manuals/W-G-III-Technical-Manual.pdf

Wu, C. (2021). Training teachers in China to use the philosophy for children approach and its impact on critical thinking skills: A pilot study. *Education Sciences, 11*(5), 206. https://doi.org/10.3390/educsci11050206

Yusuf, R., Sanusi, R., Maimun, B. A., & Putra, I. (2020). Critical thinking and learning outcomes through problem based learning model based on LBK application. *International Journal of Innovation, Creativity and Change, 12*(12), 907-918. https://www.ijicc.net/images/vol12/iss12/121285_Yusuf_2020_E_R.pdf

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.9
Cómo citar:
Leleka, V., Shevchenko, O., Ruda, I., Kholodnyi, O., & Holovchenko, O. (2024). Professional development of physical education teachers through innovative technologies. *Revista Eduweb*, *18*(4), 132-149. https://doi.org/10.46502/issn.1856-7576/2024.18.04.9

Professional development of physical education teachers through innovative technologies

Desarrollo profesional de docentes de educación física a través de tecnologías innovadoras

Vitalii Leleka
https://orcid.org/0000-0001-5680-7784
leleka9984@ukr.net
WoS Researcher ID: IWU-4464-2023
Doctor of Pedagogical Sciences, Associate Professor of the Department of Physical Culture and Sports, V. O. Sukhomlynskyi National University of Mykolaiv, Ukraine.
Olha Shevchenko
https://orcid.org/0000-0002-9493-348X
gimnast.olga@gmail.com
WoS Researcher ID: GLS-3058-2022
Candidate of Pedagogical Sciences, Associate Professor, Associate Professor of the Department of Theory and Methodology of Physical Education, Volodymyr Vynnychenko Central Ukrainian State University, Ukraine.
Iryna Ruda
https://orcid.org/0000-0002-1876-8523
tifani_ira@yahoo.com
WoS Researcher ID: IXX-0078-2023
Ph.D., of Physical Education and Sport, Associate Professor of the Gymnastics Department, Lviv State University of Physical Culture named after I. Boberskiy, Ukraine.
Olexandr Kholodnyi
https://orcid.org/0000-0002-0527-3193
holodnijalexandr@ukr.net
WoS Researcher ID: D-6847-2018
Candidate of Pedagogical Sciences, Associate Professor, Dean of the Faculty of Physical Education, Donbas State Pedagogical University, Ukraine.
Oleksii Holovchenko
https://orcid.org/0000-0003-0646-4319
alexeyg7103@gmail.com
WoS Researcher ID: AFI-1656-2022
Candidate of Sciences in Physical Education and Sport, Associate Professor, Associate Professor Department of Sporting and Physical Education, Sumy State Pedagogical University named after A.S. Makarenko, Ukraine.

Recibido: 11/10/24
Aceptado: 23/12/24

Abstract

The content of the research concepts is analyzed; the elements, qualities, structure, and factors of the professional skills of a physical education teacher related to innovative technologies are considered; the organization of an innovative educational process is described based on modern technologies and methods

of the educational process, effective, innovative methods, forms and technologies necessary for the formation of professional skills of a physical education teacher are analyzed. In the process of the study, we set the task – to develop and substantiate a methodology for the formation of professional skills of future physical education teachers in higher education institutions in the process of studying professional disciplines based on modern technologies and methods of the educational process, and also to determine whether it ensures the quality of professional training, the effectiveness of training, whether it contributes to the implementation of innovative teaching technologies, the formation of professional skills of students. The obtained data indicate positive changes in the educational process of future physical education teachers thanks to the methodology of forming professional skills based on modern technologies and methods of the educational process.

Keywords: formation of professional skills, future physical education teachers, modern immersive technologies, active, innovative methods, interactive applications, technologies of augmented and virtual reality.

Resumen

Se analiza el contenido de los conceptos de investigación; se consideran los elementos, cualidades, estructura y factores de la competencia profesional del docente de cultura física, que están relacionados con tecnologías innovadoras; Se describe la organización del proceso educativo innovador basado en tecnologías y métodos modernos del proceso educativo, se analizan métodos, formas y tecnologías innovadoras efectivas necesarias para la formación de la habilidad profesional del docente de cultura física. En el proceso de investigación nos propusimos la tarea de desarrollar y justificar la metodología para la formación de habilidades profesionales de los futuros docentes de educación física en instituciones de educación superior en el proceso de estudio de disciplinas profesionales basadas en tecnologías y métodos modernos del proceso educativo. , así como determinar si garantiza la calidad de la formación profesional, la eficacia de la formación, si contribuye a la implementación de tecnologías de aprendizaje innovadoras, la formación de habilidades profesionales de los estudiantes. Los datos obtenidos indican cambios positivos en el proceso educativo de los futuros profesores de cultura física gracias a la metodología de formación de habilidades profesionales basada en tecnologías y métodos modernos del proceso educativo.

Palabras clave: formación de habilidades profesionales, futuros profesores de educación física, tecnologías inmersivas modernas, métodos activos e innovadores, aplicaciones interactivas, tecnologías de realidad aumentada y virtual.

Introduction

In the modern world, there is a need for proactive, educated, effective, creative, active, and, most importantly, competitive professionals. That is why society places such demands on the personality of a teacher, and it is these demands that require significant efforts and dedication from the teacher. In the modern educational space, the innovativeness and competitiveness of future physical education teachers come to the fore because it is precisely the specialists who can overcome and solve the problems that arise before them, specialists who have the skills to introduce innovations into the educational process, who are highly qualified. It is not enough to be a teacher; you need to practice a lot, be a master of your craft, love your craft, and only then can you be considered a master teacher.

The professional and everyday activities of physical education teachers in the modern educational space depend on many indicators – changing the vector of individual aspirations and motivation, changes in the social, cultural, and scientific spheres, and the emergence of new ways to self-development and self-realization. That is why a modern person must be able to adapt to the world and be ready to master the competencies, qualities, and new information that will help him or her to realize himself or herself in the modern world. The same requirements are faced by future physical education teachers, who, while studying in higher education, must already develop and form those qualities that will help them in effective

professional and pedagogical activities and the implementation of their plans. (Honcharenko & Shevchenko, 2024).

We believe that professional skills are one of the most important factors in the personality of a physical education teacher, who is a true specialist and a professional in his field. Therefore, the issue of forming the professional skills of a physical education teacher based on modern technologies and methods of the educational process is determined by a new competency-based approach, which is being established in the educational process and is relevant.

The relevance of our research is determined by the low level of application of pedagogical innovations, the inconsistency of the methods of training and content of physical education teachers with modern requirements for the formation of professional skills of a physical education teacher based on modern technologies and methods of the educational process; the slow introduction of innovative modern methods in the training of future physical education teachers; the effectiveness of the system of physical education of the individual.

Literature Review

In recent years, several educational and scientific literature have been created to form a comprehensively developed personality of a teacher, increasing the level of professional skills of a physical education teacher, capable of creatively solving modern educational tasks when teaching schoolchildren in the process of their physical development.

The concept of "professional skills" is considered by T. Khoma (2021), and the ways of forming professional skills in future physical education teachers are outlined, and the components of professional skills are determined. The professional skills of a physical education teacher are considered from the point of view of the innovativeness of the educational process, the quality of performing pedagogical tasks, the manner of behavior, and the presence of pedagogical tact. The elements of professional skills are highlighted. The author presents his own interpretation of the professional skills of a physical education teacher, who possesses professional competence, encompasses a set of personal qualities, possesses innovations in the education system, is capable of self-development creativity, and is characterized by formed moral, ethical, and civic qualities.

In the conditions of the educational process of higher education, L. Chendakova (2020) highlights the features of the formation of professional skills in future teachers. Professional skills are presented as a complex of personality properties that, on a reflexive basis, provide a high level of self-organization of professional activity and combine the professional competence of the teacher with his personal and business qualities. It is proven that the professional skills of a teacher are based on pedagogical experience, general culture, high professional level of the teacher, the use of effective teaching methods, the organization of the educational process, the environment in which the educational process takes place play a significant role in the formation of professional skills of future teachers. A favorable educational environment is presented as an environment in which, with the help of the professional skills of the teacher, the interaction of all subjects of the pedagogical process is effective, physical, spiritual, moral, intellectual, and aesthetic mutual enrichment.

I. Honcharenko and O. Shevchenko (2024) highlight the features of the formation of professional skills of the future physical education teacher and analyze professional skills as a certain phenomenon, which is expressed in the productive and procedural aspects, as pedagogical activity. In the content of the concept of "professional skills of a physical education teacher", scientists include the ability to use various forms of conducting physical education classes, the choice of appropriate teaching aids and methods of the educational process, the formation of motor abilities and skills in various types of motor activity; the focus on the development and improvement of the physical condition of students of professional and pedagogical activity; the formation of positive motivation in students for motor activity and physical education classes.

Indicators of the levels of professional development of future physical education teachers are specified by M. Osadets and S. Horodynskyi (2024). In the context of continuous improvement of professional skills, formation of the need for professional self-development of a specialist in the field of sports, and renewal of the educational process in higher education, the problem of professional training of future physical education teachers is considered. The structure of professional self-development of future physical education teachers is considered to be a set of three interrelated components: reflective, motivational-emotional, and content-operational. The problem of professional training of future physical education teachers is considered in the context of continuous improvement of pedagogical skills for scientists, students, and teachers working in the field of physical education.

When analyzing the professional training of future physical education teachers, A. Protsenko (2017) considered the stages of the formation of physical education and health-improving, professional, and health-preserving competencies. The following were analyzed: readiness for pedagogical activity based on acquired skills and knowledge, main trends of the professional qualification system, criteria for the readiness of future physical education teachers: mastery of pedagogical operations and actions, methodological thinking, pedagogical orientation, and reflection.

O. Dyshko (2023) analyzes the problem of preparing future physical education specialists for sports and tourism activities. It is proven that a significant factor in further professional activity and the training of future physical education teachers is sports and tourism activities. The essence of the readiness of future physical education specialists for professional activity is revealed by the scientist, and the qualities of specialists in sports and tourism support and the main components of the professional activity of physical education specialists are determined. The latest problems in the field of sports tourism are indicated, the features of the sports component of a tourist trip are revealed, the social significance of sports tourism is outlined, the place of sports tourism in the field of physical education is determined, which is important for future physical education teachers.

Generalization of pedagogical experience and theoretical analysis of the works of scientists made it possible to find out that scientists considered the content of the concept of "professional skill" identified elements of professional skill; highlighted the features of the formation of professional skill in future teachers in the conditions of the educational process of higher education; in the context of continuous improvement of professional skill, the need to form a need for professional self-development in the individual, updating the educational process in higher education, was proven; considered the stages of the formation of physical culture and health-improving, professional, health-preserving competencies. However, the features of the formation of professional skills in future physical culture teachers based on modern technologies and methods of the educational process are not sufficiently highlighted in the scientific discourse.

Purpose of the research. To find out the features of the formation of professional skills in future physical culture teachers based on modern technologies and methods of the educational process.

Methodology

RESEARCH METHODS: theoretical: comparison, analysis, modeling, generalization, synthesis were used to study the literature on the research problem and determine the theoretical foundations of the study, clarify the features of the process of clarifying the features of the formation of professional skills in future physical education teachers based on modern technologies and methods of the educational process; empirical: observation and analysis of the educational process in higher education, conversations with students, teachers, lecturers, questionnaires and surveys of teachers and students, methods, self-assessment to identify the level of formation of professional skills based on modern technologies and methods of the educational process, an experiment to test the effectiveness of the methodology for the formation of professional skills based on modern technologies and methods of the educational process; quantitative and qualitative analysis of the results based on mathematical statistics, which were used to establish quantitative relationships between phenomena and processes, processing the data obtained.

In the process of the experimental study, we set the task – to develop and substantiate a methodology for the formation of professional skills of future physical education teachers in higher education institutions in the process of studying professional subjects based on modern technologies and methods of the educational process, and also to determine whether it ensures the quality of professional training, the effectiveness of training, whether it contributes to the implementation of innovative teaching technologies, the formation of professional skills of students.

At the ascertaining stage of the experimental study, the formation of the components of professional skills in graduate students was studied. For this, we determined the level of formation of students' professional skills, identified the need to develop the components of professional skills in future physical education teachers, and also established the degree of importance of the use of innovations in teaching professional disciplines. A questionnaire with closed-ended questions was used for this purpose and studied the respondents' self-assessment of the level of formation of professional skills of future physical education teachers. A study was conducted among practicing teachers of the level of development of professional skills at the end of the ascertaining experiment to identify the reserves of the educational process of higher education in terms of the formation of components of pedagogical skill and to verify the interdependence of professional skill and pedagogical experience.

Based on the ascertaining experiment (obtaining data), it was found that the training of future teachers requires the search and application of more effective teaching methods and methods of organization that lead to improving skills, developing the student's personality, and not only the assimilation of knowledge.

A formative pedagogical experiment was conducted with graduating students. Two groups: CG and EG, were formed before the start of the experiment.

To test the hypothesis of positive dynamics of professional knowledge and skills in work, the following were used: the $\chi 2$ criterion – to determine the independence of the EG and CG samples, calculation of the mathematical expectation and variance – to evaluate the learning outcomes.

During the formative experiment, considerable attention was paid to the methodology for the formation of professional skills based on modern technologies and methods of the educational process. At the end of the formative experiment, the experimental data were processed and systematized, the results obtained were summarized and compared with the predicted ones, conclusions were formulated, and prospects for further research of the outlined problem were determined.

The purpose of the formative stage of the experiment was to verify the effectiveness of the methodology for the formation of professional skills of future physical education teachers based on modern technologies and methods of the educational process.

Sixty-two students studying in the last years of higher education took part in the experiment. An EG (30 respondents) and a CG (32 respondents) were formed.

It was determined using the $\chi 2$ criterion that the formed groups, with a probability of 0.99 ($\alpha < 0.01$, are homogeneous. The data obtained indicate positive changes in the educational process of future physical education teachers thanks to the methodology for the formation of professional skills based on modern technologies and methods of the educational process.

We observe in the EG the highest results of the growth of organizational, gnostic, and constructive design skills. And in general, we observe positive dynamics in all skill groups.

When comparing the mathematical calculations of the studied samples – the calculation of the Student's t-criterion showed a significant difference ($t = -4.52$ with statistical significance $p = 0.01$) between the CG

and the EG. That is, the level of training of CG students differs from the level of the EG with the necessary statistical reliability.

Results and Discussion

Content of the research concepts.

The need of the hour is to increase professional skills today teachers, which includes a characteristic of a high level of professional activity. The criteria for the professional skill of a teacher in his activity are the following features: professional expediency, scientificity, creativity, humanity, effectiveness, optimal nature of the educational process, democracy, originality of approaches to educational activity (Mytnyk et al., 2024).

The professional skills of a physical education teacher are:

- A combination of the teacher's worldview, personal culture, knowledge, comprehensive theoretical training based on best practices, modern techniques, technologies, and methods of the educational process, teaching and upbringing, and pedagogical innovative technology of the educational process.
- A type of activity that characterizes the internal sphere of a physical education teacher: the desire to become a master of pedagogical work; establishing oneself as a highly qualified specialist; the belief that skill provides a sense of satisfaction from work, and not only efficiency (Knysh et al., 2024);
- The skill of a physical education teacher consists of the methodology of forming professional skills based on modern technologies and methods of the educational process, observing general norms of behavior, teaching students to perform exercises at a high level, comprehending and perceiving the unknown and new; organizing self-control, control and behavior; teaching students to design actions; directing all elements of the teacher's and students' activities to the final result of a physical education lesson and other forms of classes (Babalich et al., 2023);
- The skill of a physical education teacher is the quality of performing professional tasks and, from the point of view of axiology, depends on the axiological orientation of the teacher's personality, his professional and personal qualities, methodological experience, and creative approach to the educational process (Dzhurynskyi et al., 2023).

Elements, qualities, factors, and structure of professional skills of a physical education teacher that are associated with innovative technologies.

Elements of pedagogical skills of a physical education teacher are professional competence, humanistic orientation, pedagogical technique, and pedagogical professional abilities (Kulyk et al., 2023).

We consider professionally important qualities of the development of professional skills of a physical education teacher from the position of their formation. These are aesthetic views, moral consciousness, scientific worldview; emotional-sensory, volitional, and intellectual activity of the individual; psychophysiological, general physical readiness; style and manner of behavior, pedagogical tact; creative pedagogical search, possession of psychological and pedagogical relevant, innovative skills and knowledge to organize physical education classes, physical culture and health work, participation in scientific research work; ability to self-improvement throughout life (Matviichuk, 2015).

The importance of the professional skills of physical education teachers is expressed through factors related to innovative technologies:

1) For competitiveness and demand for teachers in the labor market, the level of professional thinking of a physical education teacher determines the level of creative potential to implement innovative components in professional activities;

2) The use of non-standard approaches to increase the level of theoretical content of professional disciplines, which leads to an aggravation of the contradiction between the real ability of a physical education teacher to solve the tasks facing him and the general goals in the educational world society;
3) An increase in the educational space of the educational and methodological base and innovative forms of teaching, new various educational technologies (Yazlovetska & Shevchenko, 2018).

The state puts forward certain requirements for the professional skills of physical education teachers, the personality of a future physical education teacher, including several general, general, and special competencies, the special and general culture of the teacher's personality, the teacher's pedagogical and special skills, and competence in implementing innovative technologies in the educational process (Honcharenko & Shevchenko, 2023).

Let us describe the structure of the professional skills of physical education teachers:

1) Professional competence, which can serve as the foundation of professional skills, adding solidity, depth, and consciousness;
2) Humanistic orientation, which is a system-forming component that is expressed in the value orientations of physical education teachers during the implementation of the teacher's self-affirmation, the goals of the specialist's pedagogical activity, as well as in his system of pedagogical interaction with students in the form of a humanistic strategy;
3) Pedagogical technique, which combines all means of pedagogical interaction and action, relies on the abilities and knowledge of the individual for effective pedagogical activity:

   - Organizational, didactic skills of mastering the technique of contact interaction, the ability to interact in the process of solving pedagogical tasks;
   - The ability to manage oneself (mastery of speech technique, emotional state, body);

4) Pedagogical abilities that facilitate the successful performance of professional functions by a physical education teacher ensure the speed of skill development:

   - Perceptive abilities (pedagogical intuition, empathy, professional vigilance);
   - Communicativeness (sociability, friendliness);
   - Personal dynamism (ability to logically persuade and influence the individual);
   - Ability to control oneself (emotional stability);
   - Ability to be creative (creativity);
   - Optimistic forecasting (Shuliak et al., 2022).

Organization of an innovative educational process based on modern technologies and methods of the educational process.

In the formation of professional skills of physical education teachers, the organization of an innovative educational process based on modern technologies and methods of the educational process plays a significant role. After all, it is in the process of educational activity of higher education that self-respect, self-esteem, tolerance, responsibility, independence, the ability to discuss and defend one's beliefs, and acceptance of the point of view of others are leveled or developed.

It will depend on what educational methods we use and whether we will form in an individual the ability to defend democratic changes based on modern technologies and methods of the educational process. Also, the process of exchange of experience and interaction between the applicants for higher education themselves. To systematize and improve professional skills and knowledge and activate one's own experience, develop memory, thinking, imagination, and attention, develop a positive attitude towards the educational process, and form the best personal qualities of a person, personality-oriented education in higher education helps. With this approach, higher education teachers collaborate with students in creating

a developmental environment, constantly make decisions, respect their right to choose and their opinions, and help them develop skills for the success of their future lives.

When teaching students, we must imagine what teaching methods will be most effective. Teachers should remember that students want to be freer in choosing a goal, are self-sufficient, may have more prejudices and stereotypes than schoolchildren, already know how to learn, have negative or positive life and educational experience, their needs and requests are clearer, preferences and interests are more established, views are balanced and moderate. Also, the behavior of students is significantly different. It is already formed in them, and therefore, students can work more concentratedly and longer, however, if learning allows them to express their thoughts and beliefs, it has important practical significance for them (Alieksieiev et al., 2023).

Students participating in the educational process should feel the need for learning, they highly appreciate the understanding that learning will help them achieve their goals. Therefore, it is worth making flexible lesson plans.

It is important for students to feel respect for themselves. Extensive practical experience should be recognized by teachers to form the professional skills of a physical education teacher, which is associated with innovative technologies. It is such an environment that ensures the implementation of co-creation within the humanistic paradigm, promotes the self-realization of the individual the development of creative potential, and forms the student's readiness for personal self-improvement (Chendakova, 2020).

The elements of the educational and favorable environment for the formation of professional skills of a physical education teacher, which are associated with innovative technologies, are:

- ***Teaching technologies, educational content*** (compliance with the current needs of the labor market – the content of the educational program, competitiveness of the educational program in the labor market, the influence of stakeholders and employers on the formation of the content of the program, the use of digital, modern, educational, production technologies in the educational process, ensuring the free choice of academic disciplines by the student);
- ***Favorable psychological climate*** (ability to trust and mutual understanding, ability to emotional communication and communication, ability to mutual respect, ability to tact in communication);
- ***Spatial environment*** (internship at leading enterprises in the industry, academic mobility, the opportunity to continue studying at higher levels of education (postgraduate, master's degree), the opportunity to find employment after training, participation in professional events (conferences, seminars, master classes, exhibitions, etc.); development opportunities (convenience of the educational environment, accessibility to the educational institution, availability of relaxation areas, safety of the environment, provision of the necessary resources for productive learning) (Kovalchuk et al., 2020).

Innovative methods, forms, and technologies are necessary for the formation of professional skills of a physical education teacher.

Innovations in pedagogical tools to form the professional skills of a physical education teacher include gamification, distance, information, and communication technologies; circuit training; non-standard and innovative equipment; game and plot techniques; individual, competency-based, creative, differentiated, personally oriented, and sportification approaches.

Innovative activities to form the professional skills of a physical education teacher consist in adapting to modern conditions of development of the educational environment, traditional methods, and forms of teaching, and in developing means and new goals of achievement, which are a form of effective and creative work of the individual. Modern requirements for the formation of professional skills of a physical education teacher based on modern technologies and methods of the educational process of pedagogical

education lead to constant changes in approaches to it. A systematic approach becomes relevant for the integration of the entire content of training and the activities of a future teacher.

In the context of the formation of professional skills of a physical education teacher, the most significant provisions are:

- Entering the world and European educational space of higher education;
- Establishing a humanistic, personally oriented paradigm of education;
- Concepts of pedagogical education, modern ideas of forming professional skills of a physical education teacher, where innovative technologies are of great importance, which create optimal opportunities for learning, consisting of various ways of organizing the educational process (Kotendzhy et al., 2023).

Such technologies have special methods of organizing innovative types of individual activity, containing a certain set of actions and procedures subject content, which creates innovative opportunities for the educational process and contributes to the instrumental provision of achieving results during the educational process.

Systematic training in physical education is one of the main principles of using innovative technologies to form the professional skills of a teacher. This principle requires the systematic formation of skills, abilities, knowledge, and logical connection of each element of educational material with another. Accessibility is an important principle for the formation of professional skills of a physical education teacher because the teacher must use the method of visualization to explain to the student how to correctly perform a particular exercise. For better understanding and assimilation of new material by children, the principle of awareness and activity is significant in teaching (Melnyk, 2020).

We consider the following innovative technologies to be quite effective in the process of forming the professional skills of a physical education teacher and the physical education of a person:

- Cooperative group learning is used to improve individual skills, promote the independent formation of professional skills and physical qualities of a person;
- Information technologies for learning include an interactive methodological and organizational complex that makes it possible to use non-standard sources of information (Internet sites, social networks);
- The use of multimedia technologies in physical education lessons will help increase the effectiveness of the educational process and contribute to the formation of the professional skills of a physical education teacher (Mostetska & Lavrin, 2022).

The leading innovative technology for the formation of professional skills of a physical education teacher is physical sports-oriented education, which is based on the use of all types of sports games. Circuit training is widespread during such lessons, thanks to which a person develops motivation and interest in systematic physical education classes.

Recently, new pedagogical technologies and innovative approaches have emerged for the formation of professional skills of a physical education teacher and effective training of physical education teachers, which allow them to form their professional skills and use the latest technologies in the educational process (Babchuk et al., 2023).

An important role in the preparation of future physical education teachers and the formation of their professional skills through the use of innovative technologies in their activities is the use of immersive technologies, including interactive applications, augmented reality, and virtual reality, which makes it possible to be part of certain simulations, interact with the digital environment. The use of such innovative

technologies can significantly improve the quality of teaching and ensure the professional skills of physical education teachers, as well as provide practical experience for future teachers (Kotendzhy et al., 2023).

To conduct innovative lessons to solve several educational tasks, a teacher needs creative thinking skills. The introduction of innovative technologies into the process of physical education makes it possible to achieve positive results during the joint work of students and the teacher, taking into account all the distinctive features of students. Therefore, an important aspect is professional skill, which consists of the creative application of innovative achievements in the successful mastery of the methodology of education and training (Shevchuk, 2023).

During our research, a methodology for the formation of professional skills for future physical education teachers was developed based on modern technologies and methods of the educational process. During classes, students were offered the use of:

- The method of “creative-linguistic reproduction”, where higher education applicants were given tasks to write a pedagogical essay on various professional topics.
- The method of creating an “associative bush” to ensure interdisciplinary connections and enrich the professional dictionary with synonymous words;
- The method of “discussion studio” to unite students into micro-groups, taking into account their learning style and personal beliefs;
- The game method, where students developed their own portfolio, in which mobile, didactic games were concentrated for students of different age groups;
- The method of sports relaxation, using a set of exercises of sports dance, aerobics, and dance fitness (Khoma, 2021);
- Interactive and active methods involving the use of E-learning techniques together with direct communication during classes with a teacher in the classroom:

1) ***Verbal*** – discussion, lecture, explanation, story, instruction, instruction, reminder, prompt, listening to audio, work with open resources (blog, website), electronic manuals and textbooks, educational catalogs, real-time discussion in online chat, processing of instructional materials, etc.;
2) ***Practical*** – exercise method: training, laboratory, and practical classes; game method (role-playing games, sports, and outdoor games); work with computer educational systems, educational programs, use of simulators and online games (stimulation, plot, role-playing); competitive method (student participation in sports competitions);
3) ***Visual*** – illustrating statistical clarity, showing, watching videos, presentations, demonstrating the technique of performing exercises, online broadcasts (sports competitions, screencasts, video lectures), etc.;
4) ***Problem-search*** – direct search for information in catalogs, thematic lists, directories, analysis of educational resources, solving problem situations, individual design and modeling, heuristic conversation, brainstorming, research laboratory work, searching for information using specialized programs, solving web quests, working together on an online project, case method, creating virtual didactic tasks, etc.;
5) ***Self-education methods*** – creating reference schemes, taking notes on educational material, independent physical exercises, completing independent work tasks, participating in sports clubs, face-to-face training, sections, creating mental maps, electronic portfolios, independent searching on the Internet and processing information taking into account professional needs and personal interests, exchanging experience and participating in online professional communities, taking training and online courses, etc.;
6) ***Methods of self-control and monitoring of educational achievements*** – observing the completion of tasks, testing, tests, written and oral surveys, checking the formation of practical skills, exams, tests, webinars, online surveys, interactive educational lectures with elements of questionnaires, formative assessment, automated test programs (Danysko & Semenovska, 2019).

Experimental methodology

In the process of experimental research, we set the task of developing and substantiating a methodology for the formation of professional skills of future physical education teachers in higher education institutions in the process of studying professional disciplines based on modern technologies and methods of the educational process, as well as determining whether it ensures the quality of professional training, the effectiveness of training, whether it contributes to the implementation of innovative teaching technologies, the formation of professional skills of students.

Analyzing the content of the physical education teacher's activity, we focused on an important component of professional skills – his professional skills – and identified the structural components of professional skills and the features of their formation. When analyzing specific professional skills, we established a sufficient and necessary level of their development in professional and pedagogical activity, studied the levels of professional skills formation in physical education teachers with different work experiences, and analyzed the features of professional activity.

To assess the professional skills of specialists, the criteria for the formation of professional skills were taken as the initial requirements, in particular: the degree of awareness of scientific foundations and goals, the degree of generalization of skills, and the consistency, completeness, and thoroughness of the operations performed.

We have identified levels that, in CG and EG students, allowed us to conclude the degree of formation of professional skills: high, medium, low, and very low.

At the ascertaining stage of the experimental study, the formation of the components of professional skills in graduate students was studied. For this purpose, we determined the level of formation of students' professional skills, identified the need to develop the components of professional skills in future physical education teachers, and also established the degree of importance of the use of innovations in teaching professional disciplines. A questionnaire with closed-ended questions was used for this purpose and studied the respondents' self-assessment of the level of formation of professional skills of future physical education teachers. Respondents were asked to choose an answer (I don’t know how, I know how, I know how well, I experience difficulties), which characterizes the level of formation of the qualities and abilities of the respondents (gnostic, organizational, constructive, design, communicative), necessary in the professional activities of physical education teachers, for their professional skills.

To identify the reasons for the insufficient formation of pedagogical skills and the formation of professional skills in the respondents, pedagogical observations were conducted during the study of professional disciplines.

During the study and discussion of the studied material, attention was paid to the activity of the respondent during the assimilation of theoretical knowledge, the ability to be guided by subjective experience, and knowledge of professional theory to solve pedagogical tasks.

A study was conducted among practicing teachers of the level of development of professional skills at the end of the ascertaining experiment to identify the reserves of the higher school educational process in terms of the formation of components of pedagogical skills and to verify the interdependence of professional skills and pedagogical experience.

Based on the ascertaining experiment (obtaining data), it was found that the training of future teachers requires the search and application of more effective teaching methods and organizational methods that lead to an increase in skills, the development of the student's personality, and not only to the assimilation of knowledge.

A formative pedagogical experiment was conducted with graduating students. Two groups: CG and EG, were formed before the start of the experiment.

A diagnosis of respondents in these groups was carried out at the beginning of the experiment, which included studying motivation for professional activity, as well as determining the level of theoretical preparedness of respondents.

A cross-section of pedagogical knowledge was conducted to identify weak links and determine the initial level of theoretical training of respondents (to use skills, knowledge, and experience when solving the tasks). To test the hypothesis about the positive dynamics of professional knowledge and skills in work, the following were used: the $\chi 2$ criterion – to determine the independence of the EG and CG samples, calculation of the mathematical expectation and variance – to evaluate the learning outcomes.

The absence of significant differences between EG and CG students was checked using the Student's t-criterion, which involved calculating the empirical value of the t-criterion, formulating statistical hypotheses (differences between the arithmetic mean of the EG and CG success are insignificant and random – zero – H0; alternative H1 – differences in the EG and CG success are significant, reliable); determining the level of significance of the t-criterion to conclude on the refutation or confirmation of our assumption.

During the formative experiment, considerable attention was paid to the methodology for the formation of professional skills based on modern technologies and methods of the educational process. This allowed us to develop educational and practical tasks to determine the ways of developing professional skills that must be applied in practical classes to effectively influence the formation of elements, methods, forms, technologies, factors, and structures of the professional skills of physical education teachers.

During the formative experiment, we tested the implementation of the proposed innovations and experimentally tested the developed methodology for the formation and improvement of the level of professional skills of graduates young physical education teachers to test the effectiveness of the methodology for the formation of professional skills based on modern technologies and methods of the educational process, which contribute to the formation of professionals.

At the end of the formative experiment, the experimental data were processed and systematized, the results obtained were summarized and compared with the predicted ones, conclusions were formulated, and prospects for further research of the outlined problem were determined.

Analysis of the state of formation of professional skills of physical education teachers.

To identify the current state of formation of professional skills in higher education among future physical education teachers, the degree of formation of the components of professional skills in students who graduated from university and have work experience from 1 to 5 years (20 people) was studied at the ascertaining stage of the experiment.

A survey was conducted, through which the levels of formation were analyzed, and data were obtained on the level of gnostic, organizational, design, and communication skills of students, which significantly characterize the readiness for the pedagogical activity of students.

Students have emphasized the importance of experience in their specialty pedagogical practice in general education schools during their studies at the university.

Having systematized the students' responses, the percentage ratio of each level of formation of pedagogical skills was determined.

Based on the data obtained, we claim that the majority of respondents believe that they can analyze pedagogical situations, organize collective activities of students, and establish constructive relationships with them.

Significant difficulties arise for respondents in the process of designing educational activities and forming professional skills based on modern technologies and methods of the educational process. 40% of future teachers experience difficulties in performing this activity, which indicates insufficient formation of design skills. 49% of graduates do not have gnostic skills, which are one of the fundamental ones in the process of becoming a future teacher or have weak skills in their activities.

This indicates that the current system of forming professional skills based on modern technologies and methods of the educational process and the formation of pedagogical skills of future specialists requires urgent improvement.

Therefore, in the educational process, we focused on the methodology of forming professional skills based on modern technologies and methods of the educational process, which is one of the reasons for the insufficient formation of students' pedagogical skills.

The analysis of pedagogical observations allowed us to identify the reasons for the insufficient formation of professional skills and pedagogical skills in specialists when studying professional disciplines:

- The predominant informational and reproductive nature of lectures,
- Weakly expressed, insufficient motivation of students for professional activity;
- Insufficient connection with the specifics of the future professional activity of specialists with educational material;
- Students' orientation to their thorough comprehension in the process of learning knowledge;
- Imperfection of the system of control of understanding and learning of educational material;
- Insufficient use of elements of mutual control and mutual learning and inclusion in the practical activities of students.

We believe that the basis of the application of new methods and techniques for organizing professional training and lifelong learning should be an activity-oriented and personally oriented approach, which will encourage self-development of the personality, allow the use of elements of developmental learning, increase the activity of students in independent work, and not only increase the level of knowledge acquisition.

Since the results of the ascertaining stage of the study indicate the need to find new ways to form professional skills and abilities at a higher level for future physical education teachers, we have developed a methodology for forming professional skills based on modern technologies and methods of the educational process and further testing its effectiveness.

Analysis of the effectiveness of the formation of pedagogical skills using the methodology for the formation of professional skills based on modern technologies and methods of the educational process in future physical education teachers.

The purpose of the formative stage of the experiment was to check the effectiveness of the methodology for the formation of professional skills of future physical education teachers based on modern technologies and methods of the educational process.

Sixty-two students studying in the last years of higher education took part in the experiment. An EG (30 respondents) and a CG (32 respondents) were formed.

To purposefully build the further process of forming professional skills of specialists, a study of the professional activities of the respondents was conducted.

At the beginning of the study, a cross-section of pedagogical knowledge allowed us to obtain the level of theoretical training of the respondents. It was determined using the χ2 criterion that the formed groups, with a probability of 0.99 (α <0.01), are homogeneous. Analyzing the correctness of the respondent's answers, we identified weaknesses that need to be paid attention to in the process of forming pedagogical skills. During the observation of the student's work, we identified their levels of preparation – low, very low, high, and medium.

After experimenting (implementation of the methodology developed by us for the formation of professional skills based on modern technologies and methods of the educational process), based on the analysis of the tasks performed by the students, we saw positive changes in the CG and the EG (improvements were recorded in mastering the theory of education and training in the ability to creatively use their knowledge during practical work). However, a significantly larger number of respondents in the experimental group were at qualitatively higher levels (Fig. 1):

EG – 33% of respondents were at a high level and 52% – at an average level;
CG – 19% of respondents were at a high level and 31% – at an average level).

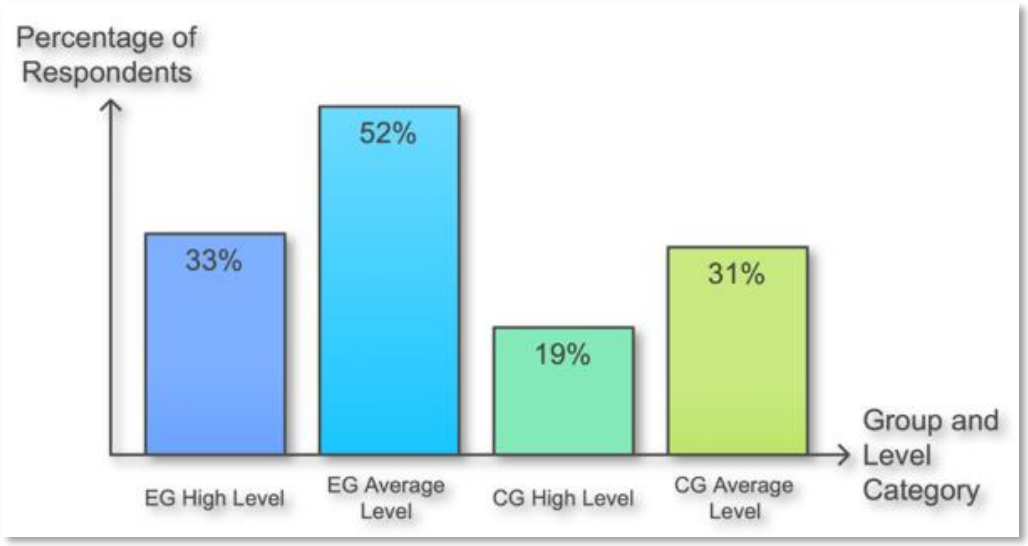

Figure 1. Comparison of Respondent Levels in Groups.

EG students (according to our observations) expressed creative ideas in solving the tasks, more often showed independence, thought outside the box, and demonstrated the formation of professional thinking.

We were also interested in how EG and CG students during the experiment would apply the skills and theoretical knowledge gained in practical classes, use their subjective initial experience, solve pedagogical tasks during physical education lessons in real practical activities, during the organization of sports and mass work with students, and conducting educational activities in general education institutions.

Based on the assessment of the student's abilities to conduct physical education and sports and mass work, physical education lessons, perform pedagogical observations in lessons, and maintain methodological documentation, a general assessment of the activities of the CG and EG in pedagogical practice at school was obtained. Data analysis showed that the level of development of practical skills and pedagogical skills in EG students is higher than in CG students.

EG students showed the ability to deeply understand the organization of educational work, implement innovative methods and techniques of upbringing and teaching, the regularities of the learning process, realize their capabilities in practical pedagogical activity, and implement them.

Analyzing the dynamics of the development of professional skills and professional-pedagogical skills based on modern technologies and methods of the educational process in EG students, we note that the increase in indicators by skill groups occurs unevenly.

After using our methodology for the formation of professional skills based on modern technologies and methods of the educational process, the highest dynamics of the results of EG students are organizational skills (organization of conducting, closing, and opening competitions) and skills that increased by 1.5 points; the ability to organize the distribution of documents – by 1.3 points; the ability to create technical support for training sessions – by 1.3 points; the ability to hold meetings – by 1.0 points; the ability to keep students in sight – by 1.0 points. The results of other skills increased (from 0.6 to 0.8 points) (Fig. 2).

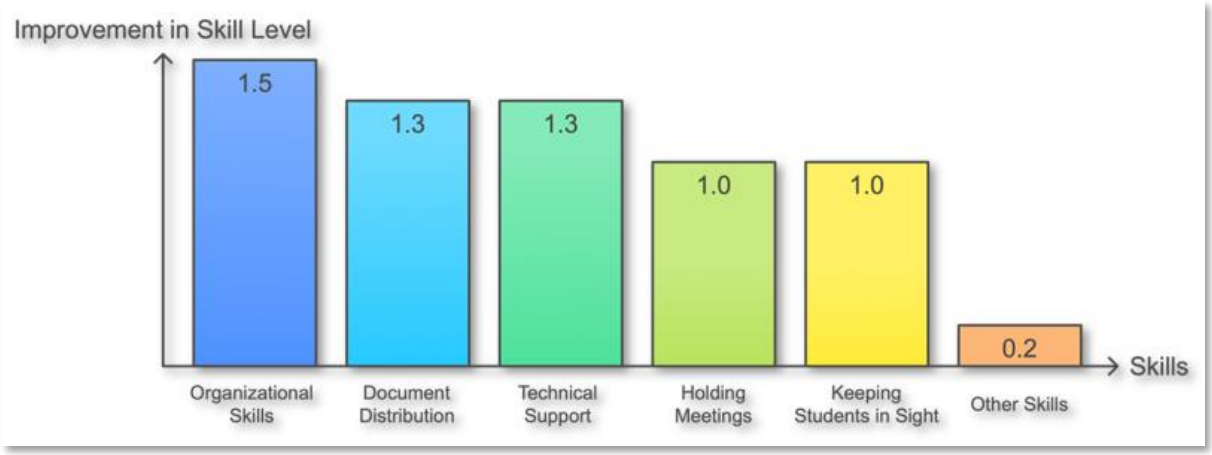

Figure 2. Improvement in Student Organizational Skills.

In EG, the gnostic skills of respondents generally have positive dynamics. The ability to identify the effectiveness of planned methods and means received the highest results (+0.98), and we also see significant results in the ability to anticipate difficulties (+0.82). And the ability to create stimulating situations (+0.41) and the ability to use traditions (+0.42) have the lowest growth rates. The remaining skills of this group increased from 0.50 to 0.59 points.

In the EG, the constructive skills of respondents increased the most in the following indicators – time allocation in the lesson (+0.86) and managing the placement of students in the gym (+0.94). Other indicators increased from 0.35 to 0.54 points.

In the EG, communicative skills improved slightly (this is because, before the experiment, these skills had the highest indicators) – in the range from 0.10 to 0.40.

In the EG, design skills show the greatest increase in skills: the ability to conduct briefings (+0.83), the ability to organize independent and individual activities of students (+0.86), the ability to provide an innovative level of modern educational and training process (+0.99). The lowest indicator (+0.24) is the creation of conditions throughout life for the successful continuation of education. The growth of indicators for the remaining skills was found in the range of 0.44 – 0.66 points.

The obtained data indicate positive changes in the educational process of future physical education teachers thanks to the methodology for the formation of professional skills based on modern technologies and methods of the educational process.

We observe in the EG the highest results of the growth of organizational, gnostic, and constructive design skills. And in general, we observe positive dynamics in all groups of skills.

When comparing mathematical calculations of the studied samples – the calculation of the Student's t-test showed a significant difference ($t = -4.52$ with statistical significance $p = 0.01$) between the CG and the EG. That is, the level of training of CG students differs from the level of EG with the necessary statistical reliability.

The presented results of the level of formation of professional skills based on modern technologies and methods of the educational process, the development of components of professional skills in EK and CG students show a significant increase in results for most components of pedagogical activity in EG. In CG, the results did not increase significantly (a significant increase in the level of professional skills based on modern technologies and methods of the educational process, professional skills are not observed for any indicator, although a tendency to increase in indicators is noted. This indicates that the methodology used for the formation of professional skills based on modern technologies and methods of the educational process is significant and necessary for its implementation in higher education institutions.

Conclusions

The content of the research concepts is analyzed; the elements, qualities, structure, and factors of the professional skills of a physical education teacher, which are associated with innovative technologies, are considered; the organization of an innovative educational process based on modern technologies and methods of the educational process is described; effective, innovative methods, forms and technologies necessary for the formation of the professional skills of a physical education teacher are analyzed.

In the process of the experimental study, we set the task – to develop and substantiate a methodology for the formation of professional skills of future physical education teachers in higher education institutions in the process of studying professional disciplines based on modern technologies and methods of the educational process, and also to determine whether it ensures the quality of professional training, the effectiveness of teaching, whether it contributes to the implementation of innovative teaching technologies, the formation of professional skills of students.

At the ascertaining stage of the experimental study, the formation of the components of professional skills in graduate students was studied. Based on the ascertaining experiment (obtaining data), it was found that the training of future teachers requires the search and application of more effective teaching methods and organizational methods that lead to an increase in skills, the development of the student's personality, and not only to the assimilation of knowledge.

The formative experiment was conducted with graduating students. Two groups: CG and EG, were formed before the beginning of the experiment.

To test the hypothesis about the positive dynamics of professional knowledge and skills in work, the following were used: the $\chi 2$ criterion – to determine the independence of the EG and CG samples, calculation of the mathematical expectation and variance – to evaluate the learning outcomes.

During the formative experiment, considerable attention was paid to the methodology for the formation of professional skills based on modern technologies and methods of the educational process. At the end of the formative experiment, the experimental data were processed and systematized, the results obtained were summarized and compared with the predicted ones, conclusions were formulated, and prospects for further research of the outlined problem were determined. The data obtained indicate positive changes in

the educational process of future physical education teachers thanks to the methodology of forming professional skills based on modern technologies and methods of the educational process. We observe in EG the highest results of the growth of organizational, gnostic, and constructive design skills. And in general, we observe positive dynamics in all groups of skills.

We see prospects for further scientific research in the study of innovative approaches to organizing the independent work of students.

Bibliographic references

Alieksieiev, O., Zubal, M., Raytarovska, I., Skavronskyi, O., & Babiuk, S. (2023). Implementation of blended learning in the student's training of the specialty physical culture and sports. *Amazonia Investiga, 12*(70), 156–166. https://doi.org/10.34069/AI/2023.70.10.14

Babalich, V., Sobko, N., Maleniuk, T., Sobko, S., & Kovalova, Y. (2023). Modern trends of physical education and sports in the education system of Ukraine. *Amazonia Investiga, 12*(71), 199–213. https://doi.org/10.34069/AI/2023.71.11.17

Babchuk, M. I., Babchuk, O. G., Asieieva, Y., Vdovichenko, O., & Melnychuk, I. (2023). Psychological features of physical perfectionism in personality. *Amazonia Investiga, 12*(66), 163–174. https://doi.org/10.34069/AI/2023.66.06.16

Chendakova, L. (2020). Pedagogical mastery formation of future teachers of professional training. *Young Scientist, 7*(83), 195–198. https://doi.org/10.32839/2304-5809/2020-7-83-42

Danysko, O., & Semenovska, L. (2019). Description of future physical culture teachers' professional training methods in terms of blended learning. *Pedagogical Sciences*, *(74)*, 43-48. https://doi.org/10.33989/2524-2474.2019.74.196647

Dyshko, O. L. (2023). Training of future specialists in physical culture to sports and tourism activity. Pedagogical Sciences: *Theory and Practice*, *(3)*, 56-62. http://journalsofznu.zp.ua/index.php/pedagogics/article/view/3916

Dzhurynskyi, P., Broiakovskyi, O., Tsviakh, O., Koshliak, M., Turchak, A., & Zalizniak, A. (2023). Innovative dimension of effectiveness in physical education student learning. *Amazonia Investiga, 12*(72), 167–179. https://doi.org/10.34069/AI/2023.72.12.15

Honcharenko, I. S., & Shevchenko, O. V. (2024). Innovative technologies in the system of forming pedagogical skills of future teachers of physical culture. *Scientific Notes. Series: Pedagogical Sciences*, *(213)*, 110–114. https://doi.org/10.36550/2415-7988-2024-1-213-110-114

Honcharenko, I., & Shevchenko, O. (2023). Peculiarities of pedagogical skills of future teachers of physical culture. *Health & Education*, *(4)*, 240–245. https://doi.org/10.32782/health-2023.4.34

Khoma, T. (2021). Formation of pedagogical skills of future teachers of physical culture. *Pedagogy of the Formation of a Creative Personality in Higher and General Education Schools, 75*(3), 123–127. https://doi.org/10.32840/1992-5786.2021.75-3.24

Kotendzhy L. V., Deka I. P., Boichenko S. V. (2023). Modernization of the process of training physical education teachers in higher educational institutions of Ukraine: standards, innovative models. *Academic Visions*, *(17).* https://www.academy-vision.org/index.php/av/article/view/267

Kovalchuk, V., Marynchenko, I., & Yashchuk, S. (2020). Creation of favorable educational environment in the higher education institutions of Ukraine. Society. Integration. Education. *Proceedings of the International Scientific Conference, 1*, 465–480. https://acortar.link/TDpMRB

Knysh, I., Budanova, O., Vakulenko, S., Syrotina, O., & Popychenko, S. (2023). Innovative educational technologies as a way of higher education enhancement. *Amazonia Investiga*, *12*(68), 21–32. https://doi.org/10.34069/AI/2023.68.08.2

Knysh, I., Drobin, A., Filimonova, T., Koycheva, T., Kushnir, A., & Kuchai, O. (2024). The use of information technologies in the educational space of Ukraine (on the example of STEAM technologies). *Revista Conrado, 20*(100), 437–448. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3979

Kulyk, N., Masliuk, R., Kyselov, V., Voropai, S., & Koycheva, T. (2023). Formation of ICT competence in future specialists of physical education and sports in the conditions of distance learning. *Amazonia Investiga, 12*(70), 241–254. https://doi.org/10.34069/AI/2023.70.10.22

Matviichuk, T. F. (2015). *Formation of pedagogical skills of future physical education teachers in the process of professional training: candidate of pedagogical sciences dissertation*. Lviv: Lviv scientific and practical center of the institute of vocational and technical education. https://repository.ldufk.edu.ua/handle/34606048/21872

Melnyk, N. (2020). Application of innovative technologies in physical education. *Student Scientific Bulletin*, *(45)*, 168–171. http://dspace.tnpu.edu.ua/bitstream/123456789/17017/1/67_Melnyk.pdf

Mostetska, O., & Lavrin, H. (2022). Application of modern gadgets in the process of physical education. *Problems and Prospects for the Development of Sports Games and Martial Arts in Higher Education Institutions, 1*, 142–145. http://journals.uran.ua/pprsievnz/article/view/252684

Mytnyk, A., Uninets, I., Ivashkevych, E., Rashkovska, I., Ivashkevych, E., & Kuchai, O. (2024). Formation of professional competence in future psychologists using innovative technologies. *Revista Conrado, 20*(100), 293–304. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3963

Osadets, M., & Horodynskyi, S. (2024). Formation of the need for professional self-development of the future specialist in the field of physical culture and sports. *Physical Culture and Sport: Scientific Perspective, 1*(1), 262-268. https://archer.chnu.edu.ua/xmlui/handle/123456789/9927

Protsenko, A. A. (2017). Structure of preparation of future teachers of physical culture for the formation of professional competence. *Collection of Scientific Papers "Pedagogical Sciences," 2*(76), 121–125. https://ps.journal.kspu.edu/index.php/ps/article/view/410

Shevchuk, I. (2023). Preparation of future teachers for the use of innovative technologies in the process of physical education of children of primary school age. *Academic Visions*, *(19)*. http://dx.doi.org/10.5281/zenodo.7966734

Shuliak, A., Hedzyk, A., Tverezovska, N., Fenchak, L., Lalak, N., Ratsul, A., & Kuchai, O. (2022). Organization of Educational Space Using Cloud Computing in the Professional Training of Specialists. *International Journal of Computer Science and Network Security, 22*(9), 447-454. https://doi.org/10.22937/IJCSNS.2022.22.9.58

Yazlovetska, O. V., & Shevchenko, O. V. (2018). *Pedagogy of physical education and sports activities* [Textbook]. Kharkiv: Machulin. http://library.kpi.kharkov.ua/files/new_postupleniya/pefivi.pdf

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.10
Cómo citar:
Sánchez-Trujillo, M.de los A., Bernabé-Sánchez, E., Sáenz-Egúsquiza, F.D., & Rodríguez-Flores, E.A. (2024). Uso del portafolio virtual para la gestión del aprendizaje de estudiantes de postgrado. *Revista Eduweb*, *18*(4), 150-164. https://doi.org/10.46502/issn.1856-7576/2024.18.04.10

Uso del portafolio virtual para la gestión del aprendizaje de estudiantes de postgrado

Using the virtual portfolio for managing the learning of postgraduate students

María de los Angeles Sánchez-Trujillo
https://orcid.org/0000-0002-5228-4688
pchemsan@upc.edu.pe
Universidad Peruana de Ciencias Aplicadas, Docente, Lima, Perú.
Estefanía Bernabé-Sánchez
https://orcid.org/0000-0001-9361-0972
ebernabe@faculty.ie.edu
IE University, Docente, Madrid, España.
Felícita Delia Sáenz-Egúsquiza
https://orcid.org/0000-0003-0921-362X
pcsifsae@upc.edu.pe
Universidad Peruana de Ciencias Aplicadas, Docente, Lima, Perú.
Eduar Antonio Rodríguez-Flores
https://orcid.org/0000-0003-0807-6686
erodriguezf@continental.edu.pe
Universidad Continental, Jefe de Investigación y Grados, Lima, Perú.

Recibido: 01/11/24
Aceptado: 21/12/24

Resumen

El objetivo del presente estudio fue implementar el uso del portafolio digital en Google Drive como herramienta de mejora en la gestión del aprendizaje en estudiantes de postgrado de una universidad privada de Lima. Esta investigación corresponde a un enfoque cualitativo y un diseño metodológico de investigación-acción. Para ello, se contó con una muestra compuesta de dos docentes y 10 estudiantes de la maestría en Educación de una universidad privada de Lima. En la etapa diagnóstica, se aplicó una guía de entrevista grupal dirigida a los estudiantes; mientras que, en la fase de evaluación, una guía de análisis documental de los portafolios digitales y una guía de entrevista grupal dirigida a los estudiantes. Entre los resultados, destaca que, a partir de la implementación del portafolio, los estudiantes mejoraron sus habilidades de pensamiento crítico, resolución de problemas y aprendizaje autónomo, además de ciertas destrezas investigativas. Además, evidenciaron percepciones positivas hacia la retroalimentación. Por tanto, se concluye que el empleo de dicha herramienta digital es potencialmente positivo para el fortalecimiento de la gestión del aprendizaje.

Palabras clave: Enseñanza superior, gestión del conocimiento, sistema de información de gestión, tecnología de la información, aprendizaje activo.

Abstract

The objective of this study was to implement the use of the digital portfolio in Google Drive as a tool to improve learning management in postgraduate students from a private university in Lima. This research corresponds to a qualitative approach and an action-research methodological design. For this, there was a sample composed of two teachers and 10 students of the Master's degree in Education from a private university in Lima. In the diagnostic stage, a group interview guide addressed to the students was applied; while, in the evaluation phase, a documentary analysis guide for digital portfolios and a group interview guide for students. Among the results, it stands out that, from the implementation of the portfolio, the students improved their critical thinking skills, problem solving and autonomous learning, in addition to certain investigative skills. In addition, they showed positive perceptions towards feedback. Therefore, it is concluded that the use of said digital tool is potentially positive for strengthening learning management.

Keywords: Activity learning, higher education, information technology, knowledge management, management information systems.

Introducción

Desde hace algunas décadas, las maneras como se conciben los procesos de enseñanza y aprendizaje han estado evolucionando. Así, el uso de las tecnologías de la información y comunicación (TIC) han posibilitado cambios en la forma en que se ejerce la docencia, especiamente, en educación superior (Acosta y Nin, 2021; Rodríguez Espinosa et al., 2014). De hecho, la sociedad del conocimiento demanda nuevas perspectivas en la educación y la forma como se incentiva la participación del alumnado (Cardona Torres et al., 2016; Sánchez, 2016; Acevedo Mena, & Romero Espinoza, 2019). Al respecto, un estudio del Instituto de Estadística de la Unesco (2013) reveló que, en América Latina y el Caribe, el 82 % de los países han adoptado al menos una política formal relacionada con la integración de las TIC en la educación, abarcando todos los niveles educativos, incluida la educación superior.

Pese a lo anterior, diversos estudios evidencian falencias en el uso de TIC por parte de los docentes como de los estudiantes, lo que imposibilita su aprovechamiento en las situaciones de enseñanza y aprendizaje (Rodríguez Espinosa et al., 2014; Montano, 2021). De esta manera, como señala Montano (2021), aunque muchos docentes utilizan recursos tecnológicos, estos son tradicionales, tales como proyectores, diapositivas y correo electrónico, por lo que no satisfacen las necesidades del alumnado. Por su parte Ureta y Rossetti Beiram (2020) afirman que, pese a que las TIC representan un entorno motivador para los estudiantes, las prácticas educativas no se enfocan en el desarrollo de competencias digitales. Así, se incluyen herramientas digitales, pero estas obedecen, en muchos casos, a entornos rígidos que no implican una mayor interacción, construcción o socialización del conocimiento por parte de los estudiantes. Teniendo en cuenta lo anterior, justamente, Ureta y Rossetti Beiram defienden la idea de emplear el término “TAC” en vez de “TIC” para centrarse en el uso de tecnologías para el aprendizaje y el conocimiento, en vez de restrigirlo a la información y la comunicación.

Ahora bien, en estudios de postgrado cobra especial relevancia el desarrollo de este tipo de habilidades, puesto que, en este nivel, los estudiantes requieren realizar procesos exhaustivos de investigación que implican el uso activo de las herramientas digitales. En efecto, como afirman Barragán De Anda et al. (2021), se espera que los estudiantes de postgrado logren la formación de competencias duras y blandas que les permitan un mayor y mejor acercamiento a la información, el establecimiento autónomo de conexiones entre los saberes previos y los nuevos contenidos, además del reconocimiento de los elementos del contexto como parte de sus procesos de análisis y reflexión. Sin embargo, como señalan George Reyes, & Salado Rodríguez (2018) y Cruz-Rojas et al. (2018), es posible identificar ciertos factores limitantes, como la carencia de una infraestructura tecnológica por parte de las instituciones, falta de software especializado, además de docentes que no incorporan efectivamente herramientas tecnológico-investigativas en sus clases.

El uso de portafolios digitales en la educación superior, y específicamente a nivel de postgrado, se justifica

por su capacidad para promover un aprendizaje autónomo, reflexivo y colaborativo, características esenciales en la formación de profesionales competentes en el siglo XXI. Estas herramientas, respaldadas por plataformas como Google Drive, permiten a los estudiantes organizar, documentar y reflexionar sobre su progreso académico de manera estructurada y accesible. En América Latina, según el Informe Regional de América Latina realizado por la Universitat Oberta de Catalunya (UOC) (2023), el 85 % de las instituciones han adaptado sus planes de estudio a modalidades digitales desde 2017. Por tanto, los portafolios digitales representan una solución eficaz para afrontar desafíos como la personalización del aprendizaje y la mejora de habilidades investigativas. Además, su funcionalidad *offline* contribuye a mitigar las barreras de conectividad que afectan a estudiantes de entornos rurales y urbanos por igual. A su vez, en un contexto donde el 62 % de las universidades de la región han acelerado su transformación digital tras la pandemia (UOC, 2023), estas herramientas no solo complementan la enseñanza, sino que también potencian la capacidad de los estudiantes para gestionar su aprendizaje de manera efectiva y autónoma.

En el presente estudio, se consideró la necesidad de indagar más, en principio, acerca de las herramientas empleadas por los docentes en relación con la gestión del aprendizaje y si estas posibilitaban el desarrollo de las competencias esperadas en los estudiantes. A partir de las falencias detectadas, se optó por aplicar una medida remedial (el uso del portafolio digital en Google Drive) con el fin de mejorar la manera como se estaban gestionando los procesos de enseñanza y aprendizaje. La pregunta general de investigación fue la siguiente: ¿De qué manera la implementación del portafolio digital en Google Drive mejora la gestión del aprendizaje en estudiantes de postgrado de una universidad privada de Lima? En tal sentido, se buscó, como objetivo general, implementar el uso del portafolio digital en Google Drive como herramienta de mejora de la gestión del aprendizaje en estudiantes de postgrado de una universidad privada de Lima. Por otro lado, se propusieron las siguientes preguntas específicas: a) ¿qué aspectos de la gestión del aprendizaje son más susceptibles de mejorar con el uso del portafolio digital en Google Drive?, b) ¿cómo perciben los estudiantes de postgrado el uso del portafolio digital en Google Drive como una herramienta de apoyo para su aprendizaje?, y c) ¿qué habilidades relacionadas con la gestión del aprendizaje se fortalecen a través del uso del portafolio digital en Google Drive? Los objetivos específicos alineados a tales preguntas fueron los siguientes: a) identificar los aspectos de la gestión del aprendizaje que pueden mejorarse mediante la implementación del portafolio digital en Google Drive, b) explorar las percepciones de los estudiantes de postgrado sobre el uso del portafolio digital en Google Drive como herramienta educativa, y c) analizar las habilidades desarrolladas por los estudiantes relacionadas con la gestión del aprendizaje al utilizar el portafolio digital en Google Drive.

El presente artículo está estructurado en tres secciones principales. En la primera, se desarrolla el marco teórico, el cual fundamenta el estudio y describe conceptos clave como el uso de Google Drive en la educación y las competencias investigativas. En la segunda sección, se expone la metodología empleada, detallando el diseño de la investigación, los instrumentos utilizados, y las estrategias para la recolección y análisis de datos. Enla tercera sección, se presentan y discuten los resultados obtenidos, estableciendo conexiones con los objetivos del estudio. Finalmente, se presentan las conclusiones centrales del trabajo realizado.

Referentes teóricos o revisión de literatura

El uso adecuado de herramientas digitales permite una adecuada gestión del aprendizaje, la cual puede definirse como la capacidad de buscar, procesar, analizar y organizar la información de fuentes diversas a partir de la aplicación de estrategias efectivas (Medina-Sánchez et al., 2021; Espinoza & Miguel, 2021; Peña & Barragán, 2022). Además, implica un ejercicio consciente por parte del docente, de modo que oriente efectivamente ese proceso. Por su parte, Bretel (2018) enfatiza en la importancia de fomentar este tipo de actividades, puesto que posibilitan, desde el punto de vista didáctico, enfocarse no solo en el saber que el estudiante adquirirá, sino en la funcionalidad de dicho saber y en el procedimiento que deberá desarrollar para lograrlo. De este modo, Vidal Ledo et al. (2014) enfatizan en la necesidad de que las actividades de formación que se desarrollen estén centradas en el estudiante y preferentemente en el trabajo colaborativo.

Ahora bien, Soubal (2008) señala que las acciones necesarias para abordar la gestión del aprendizaje deben conducir al desarrollo de destrezas del pensamiento que permitan procesar, analizar e interpretar el conocimiento, tales como la comparación, la clasificación, la inducción, la deducción, el análisis de errores, la abstracción, la síntesis, el pensamiento crítico, el pensamiento creativo, entre otros. Además, deben incentivar el uso significativo del conocimiento mediante tareas de resolución de problemas, toma de decisiones e indagación experimental. De esta forma, se evitará el planteamiento de tareas marcadamente reproductivas, de evaluación meramente sumativa, desconectadas de las propias necesidades o expectativas, y carentes de recursos que permitan transmitir lo aprendido a otras situaciones.

Esta forma de gestionar el aprendizaje se basa en el constructivismo como enfoque teórico, pues se asume al aprendizaje como un proceso activo de construcción personal, el cual busca mejorar las competencias mediante la propia autorregulación y sobre la base de la interacción en un entorno significativo (Ruiz et al., 2016; Valverde-Berrocoso et al., 2012). Por tal motivo, la evaluación por competencias relacionada con la gestión del aprendizaje se orienta a desarrollar evaluaciones auténticas, con complejidad cognitiva, imparciales, significativas, que evidencien una interpretación directa y que impliquen una toma de decisiones planificada. Por otro lado, esta manera de comprender la gestión del aprendizaje se basa en el conectivismo en la medida en que facilita la generación de redes de aprendizaje o de situaciones de aprendizaje compartido, además del aprovechamiento colaborativo de la gran información que existe en la red (Fernando & García Martínez, A, 2016).

Una opción fundamental entre la gran variedad de herramientas digitales para la gestión del aprendizaje es el portafolio como recurso que favorece tanto el trabajo docente como del alumnado. Así, puede ser un excelente recurso de reflexión sobre la práctica docente, así como un medio de planificación y evaluación (Salazar Mercado & Arévalo Duarte, 2019; Montano, 2021; Campos et al., 2021). De este modo, el portafolio facilita el seguimiento de actividades que se ejecutan de manera digital en clase, y fuera de ella. De esta forma, muestra la evolución del proceso de enseñanza y aprendizaje, por lo que resulta una herramienta fundamental para la reflexión y metacognición. Además, facilita la autonomía de los estudiantes, favorece el pensamiento crítico, representa una fuente de evaluación formativa, conserva información del estudiante en diversos formatos, es versátil, contribuye con el trabajo colaborativo, favorece hábitos cognitivos, se adapta a diversas necesidades, entre otros (Peña y Barragán, 2022; Tipán et al., 2021; Montano, 2021; Murillo Sancho, 2012).

Según sus posibilidades didácticas, Murillo Sancho (2012) clasifica el portafolio de la siguiente manera: a) portafolio de habilidades, cuyo propósito es mostrar el proceso formativo y las destrezas adquiridas; b) de historias de vida, enfocado en evidenciar las capacidades desarrolladas, además de los aprendizajes construidos en un periodo específico; c) para un curso, en el que se organizan las actividades de una asignatura; d) tipo vitrina, en el cual se muestra el mejor trabajo, el trabajo mejorado, el preferido, etc.; e) el de cotejo, en el que se presenta evidencias específicas de trabajo; f) de formato abierto, que busca construir procesos específicos sobre la base de ciertas orientaciones generales; y g) portafolio docente, que busca recopilar información y evidencias de la práctica del docente.

El portafolio concebido como un repositorio de registro de evidencias implica que, desde la práctica pedagógica, se planifique y ejecute un procedimiento metodológico que incluya técnicas y actividades debidamente relacionadas y en las que su uso tenga una funcionalidad particular; y un procedimiento valorativo, que articule evidencias que garanticen el desarrolla de las competencias esperadas. No obstante, algunos aspectos que pueden resultar limitantes o problemáticos en su uso es el alto nivel de compromiso y responsabilidad que implica por parte del alumno, la necesidad de dejar de lado totalmente los esquemas tradicionales de enseñanza y aprendizaje, la obligatoridad de establecer un proceso claro de evaluación, entre otros (Murillo Sancho, 2012).

Existen diversos recursos que pueden utilizarse para aplicar los portafolios digitales. Existen diversos recursos que pueden emplearse para la implementación de portafolios digitales en el ámbito académico. Ureta & Rossetti (2020) destacaron que el uso de Google Drive favorece significativamente el trabajo

colaborativo entre estudiantes al permitir la edición sincrónica de documentos y optimizar la gestión del tiempo en las tareas académicas. Por su parte, Coaquira Charca et al. (2020) enfatizaron que esta herramienta también es clave para el desarrollo de habilidades investigativas, ya que facilita la organización y el acceso compartido a los recursos necesarios durante el proceso de aprendizaje. Ambas investigaciones coinciden en que estas tecnologías son fundamentales para promover dinámicas de aprendizaje más efectivas y autónomas. Igualmente, Massola (2021) concluyó que el Google Drive es un incentivo para la escritura colaborativa, además de representar un estímulo para la exploración de otros recursos. Adicionalmente, representa un recurso relevante para la retroalimentación. Así, Colombo & Álvarez (2021) desarrollaron un estudio con estudiantes de postgrado y concluyeron que la retroalimentación, en este medio, promueve la autonomía, la autoconfianza, una mejor aceptación a la crítica, además de posibilitar la revisión entre pares.

A partir de ciertos estudios realizados, se ha comprobado que el uso de este tipo de recursos facilita la adquisición de competencias que permiten mejorar los procesos de enseñanza-aprendizaje (Acosta & Nin, 2021; Montano 2021; González Torres, 2021). Además, impacta positivamente en la percepción del alumnado, quien percibe un mayor involucramiento en este proceso (Colombo y Álvarez, 2021). Difabio & Alvarez (2020), por su parte, resaltan el empleo de Google Drive en el desarrollo de trabajos de tesis, aportando positivamente a la labor que realiza el director de tesis, quien puede participar de manera más efectiva y directa en el progreso evidenciado por el alumnado.

Para finalizar, algunos hallazgos evidencian las dificultades que enfrentan los estudiantes de educación superior en la aplicación de este tipo de recursos. Así, George Reyes, & Salado Rodríguez (2018) señalan que los estudiantes de postgrado, si bien utilizan frecuentemente las tecnologías para comunicarse y buscar información, evidencian diversas falencias cuando deben acceder a fuentes confiables, emplear recursos para el análisis de la información y participar en la difusión de sus conocimientos mediante herramientas y plataformas. Tal situación sucede tanto a nivel de postgrado como de pregrado, pues el estudio de González Torres (2021) concluyó que un gran porcentaje de los estudiantes universitarios evidencian un manejo deficiente de herramientas de gestión del aprendizaje, como Google Drive.

A partir de lo anterior, se hace necesaria la realización de más estudios orientados a describir las fortalezas y oportunidades de mejora de los estudiantes de nivel superior en el dominio de este tipo de herramientas con miras al favorecimiento de su aprendizaje. En particular, es preciso incentivar más la realización de investigaciones a nivel de postgrado al no existir estudios suficientes que describan esta situación y que sirvan de base para plantear propuestas de acción.

Metodología

La presente investigación es cualitativa, ya que, como señalan Hernández & Mendoza (2018), este enfoque se caracterizar por estar orientado al análisis profundo de las percepciones y las interpretaciones que se generan en individuos que participan en un fenómeno en particular. Asimismo, esta indagación sigue los principios de la investigación-acción, la cual, según Latorre (2005), parte del estudio diagnóstico de una realidad con la finalidad de comprendarla y modificar los aspectos que no sean funcionales para un óptimo desenvolvimiento de los procesos de enseñanza y aprendizaje dentro de contexto educativos. Específicamente, se siguió el Modelo de Whitehead (1989, como se cita en Latorre, 2005), el cual plantea una estrecho diálogo entre teoría educativa y el desarrollo profesional del profesorado. Esto ocurre partiendo de la identificación de un problema en la práctica docente, lo cual conduce a planificar una solución para así ejecutarla, evaluarla y motivar la transformación de las prácticas profesionales.

Para este estudio, la población estuvo compuesta por los cuatro docentes y los 100 alumnos del curso Metodología de la Investigación de la maestría en Educación de una universidad privada de Lima, la cual está compuesta de dos ciclos de estudios, cada uno de una duración de seis meses. Asimismo, a partir de un muestro no probabilístico por conveniencia, se determinó que la muestra estuviera compuesta por dos docentes y 10 estudiantes. Cabe precisar que el trabajo de campo inició desde el segundo mes de

iniciadas las clases (setiembre de 2020) y culminó en mayo de 2021, momento en que los estudiantes se encontraban cursando el segundo ciclo de estudios.

En lo que respecta al diagnóstico del problema y la evaluación de la medida remedial aplicada, se utilizó como técnicas de recojo de datos el grupo focal y el análisis documental, e instrumentos como la guía de entrevista grupal y la guía de análisis documental respectivamente. El proceso ejecutado en el presente estudio se puede visualizar en la Figura 1:

Figura 1. Fases de ejecución del trabajo de campo.

Respecto de los procedimientos realizados, en primer lugar, se solicitó el permiso a las autoridades de la escuela de postgrado de la institución educativa para realizar la investigación. Luego, se programó una primera entrevista grupal con la finalidad de diagnosticar aspectos relacionados con la gestión del aprendizaje del curso Metodología de Investigación, previa solicitud de consentimiento a los estudiantes considerados para ser informantes. Posteriormente a la aplicación de los portafolios en Google Drive, se realizó una revisión de los mismos después de solicitar a los docentes el acceso a los mismos. De igual modo, se realizó una segunda entrevista grupal a los estudiantes con el propósito de identificar sus percepciones y experiencias sobre el uso del portafolio digital como herramienta para mejorar la gestión del aprendizaje en el curso Metodología de la Investigación.

Luego de haber recopilado los datos, se procedió a ejecutar el procesamiento de información, para lo cual se empleó principalmente el Atlas ti, software que facilitó la integración y contraste de los datos cualitativos. Además, para el análisis e interpretación efectuadas para la evaluación de la medida, se utilizó la triangulación de resultados mediante el empleo de matrices de organización con el fin de establecer aquellos aspectos comunes, producto de la confluencia de los dos instrumentos de investigación aplicados en esta etapa.

Resultados y discusión

Resultados de la primera guía de entrevista grupal

En relación con las herramientas o recursos didácticos que utilizan los docentes de Metodología de Investigación para promover el aprendizaje en el curso, destacan las clases magistrales vía Zoom. Así, los estudiantes concordaron en que los profesores solían explicar los contenidos de forma expositiva y haciendo uso, generalmente, de diapositivas de Power Point, videos o lecturas que solían proyectar. Asimismo, declararon que solían brindar un espacio de intervenciones y preguntas para absolver las dudas

surgidas durante las explicaciones. Por otro lado, también señalaron que, para la parte aplicativa, los docentes solían utilizar formatos que los estudiantes debían completar acerca de las distintas etapas del proceso de investigación con miras al desarrollo de su tesis. Así, mencionaron que, por ejemplo, había un formato para la exploración del posible tema de investigación, un formato para la identificación del tema, un formato para la búsqueda de fuentes, entre otros. Además, indicaron que los docentes subían, en la plataforma digital, los formatos en archivos Word que los estudiantes debían descargar y completar para posteriormente ser enviados también vía dicha plataforma en las fechas planteadas.

Por otro lado, los estudiantes declararon que los docentes no solían emplear recursos digitales variados para mejorar la experiencia de aprendizaje en el curso. En todo caso, el único medio digital que solía emplear con frecuencia era la plataforma institucional, principalmente, con dos intenciones: calificar los trabajados enviados, y subir los textos y videos mostrados en clase. Al respecto, los alumnos expresaron su descontento con estas carencias, pues sentían que los docentes podían incluir más recursos digitales para favorecer su aprendizaje autónomo y habilidades de investigación.

En cuanto al desarrollo del pensamiento crítico en el curso, los estudiantes manifestaron que sí sentían que los docentes se orientaban a su reforzamiento. Las actividades principales empleadas para tal propósito fueron el estudio de casos y los plenarios. En los estudios de casos, los docentes solían plantear situaciones vinculadas con el ámbito de investigación para que los estudiantes pudieran discutir su resolución y, de esta forma, reforzaran sus habilidades investigativas y de pensamiento crítico. Un ejemplo que propusieron fue el caso de un docente que, frente a la situación de pandemia, estaba teniendo dificultades en adaptarse al entorno virtual y en generar la motivación de sus estudiantes. Ante este caso, se posibilitó que los estudiantes identifican los síntomas problemáticos y propongan algunas posibilidades de problemas de investigación. Para realizar este tipo de actividades, los profesores solían agruparlos en salas separadas, de tal forma que se fomentara su intercambio de ideas. Posteriormente, un integrante de cada equipo procedía a socializar las conclusiones del grupo. Otra actividad desarrollada por los docentes para el fortalecimiento del pensamiento crítico consistía en el desarrollo de plenarios, en los que estudiantes, de forma voluntaria, debían presentar sus actividades relativas a su trabajo de investigación. De esta manera, se fomentaba que sus compañeros pudieran comentar y aportar asertivamente a los avances presentados.

En cuanto al desarrollo de la habilidad de resolución de problemas, los estudiantes declararon no reforzarla en el curso de Metodología de Investigación. En todo caso, según manifestaron, las únicas actividades vinculadas con esta destreza eran las que concernían a la tesis en las que, justamente, debían iniciar identificando una problemática y plantear una posible propuesta de solución.

Por último, en cuanto a la retroalimentación, los estudiantes expresaron su disconformidad con la manera como esta se producía. Así, declararon que el único medio para realizar esta actividad era la plataforma, cuando debían entregar sus productos calificados. En relación con lo anterior, la retroalimentación se solía hacer solo al final del proceso sin oportunidad de revisiones previas. Cabe señalar que, aunque los estudiantes tienen la posibilidad de recibir asesorías por parte de los docentes en fechas establecidas con anticipación, manifestaron que no siempre, para tales fechas, contaban con las actividades desarrolladas. Además, indicaron que tales encuentros consistían en una asesoría principalmente oral y que, muchas veces, comentarios importantes que los docentes manifestaban no eran fácilmente captadas por ellos, lo que les imposibilitaba realizar mejoras a sus productos de forma pertinente.

Resultados de la guía de análisis documental

Respecto de la gestión de las carpetas, se identificó que cada docente creó una general, la cual sirvió como portafolio matriz, de tal forma que los docentes se aseguraban de ser los principales gestores. Dentro de ellas, cada docente colocó subcarpetas, las cuales tuvieron como función ser los portafolios específicos de cada estudiante. Por esa razón, dichas subcarpetas tenían como denominación los apellidos y nombres de los alumnos. De ese modo, los docentes podían identificar con facilidad los portafolios específicos de

sus estudiantes. Asimismo, cabe mencionar que cada subcarpeta solo estaba compartida para edición con cada alumno para que así solo él y el docente tuvieran acceso a los productos específicos. Adicionalmente, se creó una carpeta adicional en la que sí se estableció permisos de edición a todos los estudiantes de manera simultánea a fin de que ellos puedan compartir sus productos o hallazgos bibliográficos más sobresalientes.

En relación con el tiempo de atención, se identificó que existían fechas flexibles para el avance y revisión de los productos. Esto se pudo corroborar, pues las marcas de modificación que aparecían dentro de los productos de cada carpeta indicaban momentos disímiles entre estudiantes. Ello se puede deber a que un portafolio permite un avance asincrónico de actividades de acuerdo con la disponibilidad horaria de los participantes. Así, cada estudiante se vuelve responsable de su propio aprendizaje. También, en caso de que no notara actividad en el portafolio de uno de sus alumnos, cada docente pudo comunicarse con este a fin de invitarlo a retomar sus actividades académicas. Esto sirvió como evidencia del nivel de compromiso con el curso por parte de los participantes. En suma, todo este seguimiento de las carpetas requirió que los docentes invirtieran una cantidad considerable de tiempo atendiendo cada caso particular.

En referencia al empleo de recursos de retroalimentación, dado que los documentos más empleados por los estudiantes fueron Documentos de Google y Hojas de cálculo de Google, la retroalimentación brindada por el docente se centró en observaciones comentadas y sugerencias empleando las herramientas de dichos formatos de trabajo, los cuales se actualizan inmediatamente. Es así como los participantes podían, de igual modo, realizar repreguntas o resolver los comentarios de los docentes. Se identificó que adicionalmente un docente realizaba resaltados de colores a partes que requerían mayor atención de los estudiantes siguiendo patrones preestablecidos. Así, un resaltado de color amarillo significaba que existían problema de ortografía; un resaltado celeste, problemas gramaticales; un resaltado violeta, problemas de estilo APA; y un resaltado plomo, problemas de parafraseo. También, se pudo notar por las marcas de modificación y por el control de cambios que los docentes participaban todos los días por lo menos una vez por estudiante, dependiendo de la cantidad de errores que necesitaban observancia.

Por su parte, la interacción con el estudiante fue de carácter asincrónico. Debido a la naturaleza del portafolio, la retroalimentación se convirtió en el principal medio de comunicación con los participantes en dicho espacio. La interacción, en ese sentido, se redujo a la atención de aspectos eminentemente prácticos. Se asume, por tanto, que otros tipos de comunicación se realizaron en medios distintos (correo electrónico, plataforma digital, etc.). Sin embargo, esto representa una superación del esquema de trabajo anterior, pues los estudiantes habían manifestado inicialmente que no recibían retroalimentación directa de sus productos sino hasta la presentación de la versión final en la plataforma digital del curso. En todo caso, se pudo observar que uno de los docentes no solo comentaba los errores de los estudiantes, sino que también elogiaba los apartados mejor desarrollados o que habían sido adecuadamente corregidos.

Por último, respecto del impacto de la retroalimentación en los productos, se pudo identificar una notable mejora de estos como consecuencia de los constantes comentarios e invocaciones a rectificación. Este modo de brindar apoyo académico a los estudiantes en el proceso de elaboración fue muy útil para que aquellos puedan realizar mejoras significativas en sus productos y sean conscientes de los errores que ya no debían cometer en adelante. Esto incrementó notablemente la calidad de los productos. A su vez, la toma de conciencia sobre las oportunidades de mejora contribuyó con que cada semana los docentes tuvieran menos observaciones que realizar.

Resultados de la segunda guía de entrevista grupal

En relación con sus percepciones respecto del empleo del portafolio digital, los estudiantes expresaron un gran nivel de satisfacción. De esta manera, señalaron que su uso ha permitido potenciar distintas habilidades en ellos, además de garantizar un mayor seguimiento en el proceso de investigación que están realizando. Al respecto, se rescata que los estudiantes resaltaron que este recurso no solo ha facilitado tal seguimiento por parte del docente, sino también de ellos mismos como alumnos al verificar sus estados de avance y progresos.

En cuanto a las dificultades para el empleo del portafolio digital en Google Drive, los alumnos señalaron que sí tuvieron, inicialmente, ciertas dificultades por razones tales como “la falta de costumbre”, “la mala conexión a Internet”, “el trabajo de pasar las actividades ya realizadas a ese formato”, entre otras. Sin embargo, todos concordaron en que tales problemáticas han sido superadas y que ya lograron acostumbrarse al empleo de portafolio digital. En efecto, resaltaron sus ventajas para el desarrollo de un adecuado trabajo de investigación.

Sobre la atención que recibieron por parte de sus docentes cuando presentaban alguna dificultad en el uso del portafolio, los estudiantes manifestaron su conformidad, pues indicaron que sus inquietudes y consultas al respecto han sido resultas de forma oportuna, debido principalmente al domunio evidenciado por los docentes. Algunas respuestas resaltantes fueron las siguientes: “mi profesor siempre ha sido muy amable en ayudarme a manejarlo”, “el profesor maneja el Drive y es por eso que simpre nos da tips para poder usarlo mejor”, “la profesora es muy paciente y, a veces, hemos aprovechado un espacio de clase o de asesoría para realizarle consultas técnicas sobre el uso del Drive”.

En cuanto a la percepción respecto de la retroalimentación brindada por el docente, los estudiantes concordaron unánimamente en que el portafolio digital en Google Drive ha posibilitado mejorar ampliamente este aspecto. De esta forma, enfatizaron en que “ahora sí el proceso es más atendido” y, de esta manera, los docentes ya no se enfocan solamente en el producto final, sino también en los avances previos. Incluso, señalaron que, gracias a este recurso, el docente puede incluir comentarios que los estudiantes pueden atender para la mejora. Además, la herramienta, al brindar la posibilidad de revisar el historial de versiones, les ha facilitado hacer el seguimiento del progreso evidenciado en sus productos internedios.

Sobre el desarrollo del pensamiento crítico, los estudiantes manifestaron que el trabajo con el portafolio les ayudó a mejorar su capacidad de discernimiento y toma de decisiones, pues recibir constantemente retroalimentación de parte de los docentes hizo que los participantes tomaran conciencia de sus propios errores y los corrigieran mientras avanzaban. A su vez, los alumnos indicaron que muchos de los contenidos del curso no habían sido comprendidos previamente en las clases, así que con la práctica correctiva fue que pudieron comprender mejor diversos conceptos y el uso práctico de estos. También, los estudiantes recalcaron que, gracias a la experiencia del empleo del portafolio con fines didácticos, tomaron conciencia sobre la necesidad de “cuidar las etapas” y el “manejo de información”. Respecto de lo primero, aludía a que los participantes no eran muy escrupulosos con el orden lógico de la investigación, razón por la cual solían intercalar la realización de actividades, lo cual les generaba problemas de orden lógico en sus presentaciones. En relación con lo segundo, los estudiantes mencionaron que habían reconocido que su forma de emplear la información ajena no fue la más adecuada, ya que muchos de ellos no sabían cuál era la función que debía cumplir un fragmento tomado dentro de su tesis. Gracias a la retroalimentación activa de los docentes, los participantes pudieron identificar que estaban utilizando información sin criterios de selección y articulación. Dicha superación se reflejó no solo en los nuevos avances, sino también en los trabajos presentados antes del uso del portafolio.

En lo referente a la resolución de problemas, los estudiantes indicaron que si bien la retroalimentación de los docentes se enfocaba en corregir aspectos específicos en la mayoría de los casos, también se les realizó invocaciones a que busquen información siguiendo determinados parámetros de selección. Esto condujo a que los alumnos se sintieran estimulados a utilizar más herramientas, como buscadores electrónicos de revistas y repositorios digitales, software de lectura y edición de documentos, y aparatos electrónicos para la lectura y revisión de avances. En sí mismo, el uso de Google Drive representó un reto para varios de los participantes, quienes tuvieron que resolver sus dificultades de comprensión de la herramienta mediante tutoriales virtuales y consultas a los docentes. Adicionalmente, los participantes de mayor edad manifestaron que se apoyaron en sus hijos y en algunos conocidos que sí conocieran el uso de Google Drive. En suma, se estimuló que la generación de acciones correctivas frente a los retos cognitivos ya no proviniera solo de los docentes, sino que los estudiantes asuman su rol activo como participantes que toman decisiones estratégicas para su propio aprendizaje.

Ante la posibilidad de empleo del portafolio digital en Google Drive en otros cursos, los estudiantes manifiestaron que considerarían muy positivo que la estrategia utilizada en el curso de Metodología de la Investigación se replique en las demás asignaturas del programa de postgrado. Sin embargo, los participantes también consideran que el tiempo invertido en la elaboración de las actividades del curso de Metodología de Investigación fue mucho mayor con el uso del portafolio, por lo que los participantes consideran que sería un inconveniente que todos los cursos tengan una demanda temporal de similares características, dado que los estudiantes no solo cursan las asignaturas del programa, sino que deben atender diversas responsabilidades laborales, familiares y personales. En ese sentido, si bien los alumnos consideran que sería positivo que todos los cursos empleen el portafolio digital en Google Drive, también les preocupa las demandas de atención que aprender de este modo implique.

Discusión

La aplicación de la medida remedial consistente en el uso del portafolio digital en Google Drive respondió a una necesidad detectada en el diagnóstico realizado mediante la aplicación de la guía de entrevista grupal a los estudiantes. De este modo, desde su percepción, se identificó el empleo de herramientas pedagógicas tradicionales, poco interactivas y que no satisfacían sus expectativas, lo que resulta coherente con los estudios desarrollados por Rodríguez Espinosa et al. (2014) y Montano (2021). Incluso, la plataforma institucional era percibida como un entorno rígido para ellos, lo que concuerda con la afirmación de Ureta & Rossetti Beiram (2020), quienes señalan que que los recursos digitales que no permiten un dinamismo e interacción fluida con los estudiantes son percibidos de forma negativa por ellos. En cuanto a la formación de habilidades necesarias en estudiantes de postgrado, como el pensamiento crítico y la resolución de problemas, inicialmente, no estaban siendo reforzados a partir de las estrategias didácticas aplicadas, lo cual también conducía a falencias en la aplicación de aprendizaje autónomo en los estudiantes, lo que concuerda con la investigación efectuada por Barragán De Anda et al. (2021). A ello, se sumaba la falta de una retroalimentación formativa, que no se enfocara solamente en el producto final, sino en todo el proceso desarrollado por los alumnos.

Frente a las problemáticas ya mencionadas, se procedió a implementar el portafolio en Google Drive y a evaluar su uso. En esta evaluación, se pudo corroborar, en principio, la mejora en la percepción manifestada por los estudiantes, lo que concuerda con el estudio desarrollado por Colombo & Álvarez (2021), quienes defienden la idea de que este tipo de recursos, si se aplica correctamente, genera una gran aceptación por parte de los estudiantes beneficiados. Así, pese a las dificultades técnicas inicialmente mencionadas por los alumnos, se pudo superar todas estas problemáticas gracias al empleo eficaz del portafolio y del apoyo constante evidenciado por los dos docentes, tal como señalaron los estudiantes.

En el análisis documental efectuado, se pudo corroborar que los dos docentes que formaron parte de la muestra favorecieron la gestión del aprendizaje mediante el empleo del portafolio digital. En principio, al crear portafolios personalizados por cada estudiante, se pudo efectuar un seguimiento más personalizado acerca de sus avances, lo cual se vincula con una mejora en la retroalimentación ofrecida, la que se asocia a una evaluación principalmente formativa y ya no sumativa, como se efectuaba anteriormente. De esta forma, se incidió en los progresos de los productos presentados por los estudiantes, los cuales quedaban registrados en el portafolio y permitieron generar evidencias de la mejora de los estudiantes, así como del seguimiento ejecutado por los docentes.

En efecto, el Google Drive favorece la aplicación de estrategias más flexibles y dinámicas de revisión que hacen posible no solo la inserción de comentarios y correcciones por parte del docente, sino también las respuestas de los estudiantes, y por ende, la interacción entre ambos agentes educativos. Tal interacción, a su vez, no se realiza de manera sincrónica, sino asincrónica, lo que posibilita que el estudiante asuma una mayor responsabilidad respecto de su proceso de aprendizaje al organizar los espacios en que pudiera atender las correcciones y sugerencias de sus docentes, y a su vez incluir sus propias reflexiones o comentarios. En efecto, todo ello concordó con la percepción evidenciada por los alumnos, quienes manifestaron sentir que los procesos de aprendizaje, gracias al uso de esta herramienta, estaban siendo

atendidos, además de percibir una mejor atención y seguimiento por parte de los docentes, así como un mayor énfasis en el proceso y no solo en el resultado final de cada actividad de aprendizaje, tal como defienden Soubal (2008) y Zapata (2003). Entonces, es posible afirmar que se emplearon portafolios de habilidades y de formato abierto (Murillo Sancho, 2012) para verificar los progresos y avances de los estudiantes de manera dinámica e interactiva, dejando de lado prácticas tradicionales que no estaban aportando a la gestión de su aprendizaje (Colombo & Álvarez, 2021; Massola, 2021).

En relación con las habilidades desarrolladas gracias al uso de Google Drive, se favorecieron tanto las habilidades de pensamiento crítico, resolución de problemas, aprendizaje autónomo y trabajo colaborativo. De esta manera, los estudiantes percibieron una mejoría en sus capacidades de análisis y reflexión frente a la información gracias al uso adecuado del portafolio y a los comentarios registrados por los docentes. Ello les permitió comprender mejor las etapas del proceso de investigación, tomar mejores decisiones, mejorar su capacidad de discernimiento, y adquirir un mejor dominio de búsqueda y análisis de la información de fuentes sobre la base de acciones y estrategias organizadas también por ellos mismos. Esto último se opone al estudio de George Reyes, & Salado Rodríguez (2018), quienes señalan que, pese al uso de herramientas digitales, los estudiantes de postgrado suelen evidenciar dificultades respecto de la identificación de fuentes confiables. En la presente investigación, aunque ello representó una problemática al inicio, se logró superar gracias al trabajo sistemático realizado a partir de las revisiones efectuadas en el portafolio. Por otro lado, desde la percepción de los estudiantes, el empleo del Google Drive les permitió implementar acciones correctivas frente a las limitaciones o dificultades que evidenciaron en el proceso de desarrollo de su tesis, lo que ayudó a fortalecer sus habilidades de resolución de problemas y promover su aprendizaje autónomo. Según Coaquira Charca et al. (2020), el uso de esta herramienta tecnológica mejora significativamente las competencias investigativas de los estudiantes al facilitar el manejo de datos y la colaboración en tiempo real, aspectos fundamentales para abordar problemas de forma eficaz. Por su parte, Difabio y Álvarez (2020) señalan que el uso de plataformas digitales como Google Drive potencia la metacognición, al fomentar procesos de reflexión y autoevaluación que consolidan operaciones cognitivas complejas. Finalmente, Ureta y Rossetti (2021) destacan que la implementación de Google Drive en el ámbito académico promueve el desarrollo de habilidades investigativas específicas, al proporcionar un entorno que facilita tanto la gestión del tiempo como el trabajo colaborativo. Estos hallazgos coinciden en señalar que el uso efectivo de las TIC, y en particular de Google Drive, contribuye al fortalecimiento de habilidades clave en los procesos de investigación académica.

Finalmente, pese a que no formó parte de uno de los propósitos esenciales de la propuesta, el trabajo colaborativo también resultó reforzado. Ello se evidenció principalmente gracias a la carpeta compartida generada por los docentes para que los estudiantes pudieran compartir e intercambiar sus hallazgos bibliográficos más relevantes, lo que se vincula justamente con la lógica del conectivismo y la posibilidad de generar redes de aprendizaje gracias al uso de las TIC (Fernando, & García Martínez, 2016). En efecto, a partir de esta medida, los estudiantes pudieron realizar esfuerzos conjuntos para acceder a información confiable que les permitió enriquecer su trabajo de tesis, tanto a nivel conceptual (beneficioso, sobre todo, para aquellos, cuyos temas de tesis eran similares) como metodológico. Ello, a su vez, permitió el fortalecimiento de su competencia investigativa al acceder, de forma colaborativa, a fuentes de alto valor teórico y rigor metodológico bajo la supervisión del docente. Adicionalmente, en el proceso de seguimiento y mejora efectuado gracias al empleo del Google Drive, se fortalecieron las destrezas de investigación de los estudiantes, plasmadas en un adecuado y progresivo desarrollo de la tesis sobre las etapas que debe tener un trabajo de este tipo y de las que fueron conscientes los estudiantes.

En la Tabla 1, se puede identificar los componentes asociadas a la gestión del aprendizaje antes y después de la implementación del portafolio con el fin de reconocer las mejoras evidenciadas gracias a su empleo.

Tabla 1.
Mejoras evidenciadas en los componentes asociados a la gestión del aprendizaje

Componente evaluado	Antes de la implementación del portafolio	Durante la implementación del portafolio
Pensamiento crítico	Se limita a los estudios de caso y plenarios desarrollados por los docentes.	Se asocia directamente al trabajo de tesis de cada estudiante, y se relaciona con otras habilidades de reflexión, análisis, toma de decisiones, discernimiento y manejo de fuentes confiables.
Resolución de problemas	Está ausente; los estudiantes no perciben su desarrollo.	Se asocia a la resolución de las dificultades evidenciadas en el proceso de desarrollo de su tesis, gracias a los comentarios insertos por los docentes y al seguimiento realizado por ellos. Está directamente vinculada con el reforzamiento de su habilidad de metacognición.
Aprendizaje autónomo	No se evalúa ni enfatiza en esta habilidad, pues solo se revisa el producto final.	Se promueve esta habilidad al generar la posibilidad de presentar avances intermedios con flexibilidad y de manera asincrónica, incentivando la responsabilidad y organización de los estudiantes. Además, se incentiva la indagación autónoma de acciones orientadas al uso efectivo del Google Drive.
Trabajo colaborativo	No se refuerza propiamente. Se realizan trabajos de discusión grupal, pero no son propiamente colaborativos.	Se desarrolla esta habilidad al plantear la posibilidad de realizar actividades conjuntas de investigación, como la generación de una carpeta colaborativa de fuentes bibliográficas.
Habilidades investigativas	Se refuerzan mediante el empleo de los formatos que los estudiantes deben completar según las actividades que van desarrollando. Sin embargo, el avance y corrección de estos formatos dependen de las características y disposición de cada estudiante.	Se refuerzan de manera permanente, gracias a la intervención directa de los docentes en los avances de investigación que los estudiantes van presentando, siempre que estos muestren disposición a participar activamente en el desarrollo de las actividades del portafolio.
Interacción docente-estudiante	Se limita principalmente a las sesiones remotas de clase y en el espacio dispuesto por el docente. También, los estudiantes tienen la opción de comunicarse con el docente vía plataforma o por correo electrónico. Es principalmente unidireccional.	Es más fluida y horizontal. Los docentes retroalimentan constantemente, y los estudiantes tienen la opción de responder y repreguntar. Es bidireccional.
Retroalimentación docente	Se aplica principalmente al finalizar la realización de un producto, cuando este se entrega oficialmente en la plataforma institucional.	Es formativa; se realiza a partir de los avances desarrollados por los estudiantes. Se adapta a las características y avances de cada alumno.
Percepción de los estudiantes frente a la gestión de su aprendizaje	Es negativa, pues los estudiantes perciben un uso tradicional de los medios tecnológicos, además de estrategias que no favorecen el desarrollo de sus habilidades investigativas y aprendizaje autónomo.	Es positiva, pues los estudiantes perciben que el uso del Google Drive ha permitido enfatizar más en el proceso de aprendizaje y un seguimiento por parte de los docentes.

Fuente: Elaboración propia

Los resultados presentados en la Tabla 1 evidencian el impacto positivo del uso de Google Drive, principalmente, en el fortalecimiento de las habilidades de resolución de problemas y en el desarrollo de competencias de indagación científica. Estos hallazgos reflejan cómo la integración de herramientas tecnológicas puede contribuir significativamente al aprendizaje autónomo y colaborativo, lo que se alinea con los objetivos del estudio.

Conclusiones

En conclusión, a partir de las falencias detectadas, las cuales estaban asociadas a las estrategias didácticas aplicadas en el curso Metodología de investigación y en la percepción negativa de los estudiantes, principalmente, en la retroalimentación recibida por parte de sus docentes, se implementó el uso del portafolio digital para la mejora de la gestión del aprendizaje. A partir de su aplicación, se evaluó su pertinencia y se pudo identificar sus vastas potencialidades en cuanto al desarrollo de competencias investigativas y habilidades asociadas al pensamiento crítico, resolución de problemas, trabajo colaborativo, además del aprendizaje autónomo. Igualmente, se pudo corroborar una mejoría en las retroalimentaciones brindadas por los docentes, enfocadas en el proceso de aprendizaje llevado a cabo por los estudiantes para su oportuna intervención y no solo en los productos finales. De este modo, se corrobora los beneficios innegables del uso del portafolio digital en los procesos didácticos y, en particular, en aquellos vinculados con la investigación. A su vez, facilita la labor del docente y del asesor de tesis al posibilitar una mayor interacción con los estudiantes para la mejora de sus avances.

Referencias bibliográficas

Acevedo Mena, K. M., & Romero Espinoza, S. (2019). La educación en la sociedad del conocimiento. *Revista Torreón Universitario, 8*(22), 79–83. https://revistas.unan.edu.ni/index.php/Torreon/article/view/3250

Acosta, M. I., & Nin, M. C. (2021). Google Drive como facilitador de comunidades pedagógicas. Experiencias de formación continua en Didáctica de la Geografía. *Revista Geográfica Digital, 18*(35), 51-61. http://dx.doi.org/10.30972/geo.18355133

Barragán De Anda, A. B., Ávila González, C., Belmonte Herrera, A. M., Camarena Cadena, M. de J., & Gómez Valenzuela, R. (2021). Ambientes híbridos de aprendizaje en estudios de posgrado. *Revista Iberoamericana de Tecnología en Educación y Educación en Tecnología, (28)*, 149-156. https://doi.org/10.24215/18509959.28.e18

Bretel, L. (2018). *De la gestión de la enseñanza a la gestión del aprendizaje*. WMCMF. https://webdelmaestrocmf.com/portal/la-gestion-la-ensenanza-la-gestion-del-aprendizaje/

Campos, A.G., Cabrera, F.M., & Orlanzzini, O.D. (2021). Uso de Google Drive como estrategia de enseñanza aprendizaje en asignaturas de investigación en alumnos de nutrición. *Revista Educación y Tecnología, 9*(14), 23-46. https://dialnet.unirioja.es/servlet/articulo?codigo=7958044

Cardona Torres, S. A., Jaramillo Valbuena, S., & Navarro Rangel, Y. (2016). Evaluación de competencias con apoyo de un sistema de gestión de aprendizaje. *Praxis & Saber, 7*(14), 193-218. http://www.scielo.org.co/scielo.php?pid=S2216-01592016000200009&script=sci_arttext

Coaquira Charca, K. L., Mendoza Roque, E. M., & Payehuanca Choque, C. J. (2020). *Uso de Google Drive para mejorar la competencia indaga mediante métodos científicos en estudiantes de cuarto año de Educación Secundaria de la Institución Educativa "40670 El Edén Fe y Alegría 51" Arequipa 2019* (Título profesional), Universidad Católica de Santa María. https://repositorio.ucsm.edu.pe/items/34067f16-3a72-4a41-9d03-7382f5d7fab8

Colombo, L., & Álvarez, G. (2021). Iniciativas didácticas basadas en la revisión entre pares y orientadas a la enseñanza-aprendizaje de la escritura de tesis a nivel de posgrado. *Educación y Humanismo, 23*(40), 1-18. https://doi.org/10.17081/eduhum.23.40.3995

Cruz-Rojas, G., Molina-Blandón, M.A., & Valdiri-Vinasco, V. (2018). Vigilancia tecnológica para la innovación educativa en el uso de bases de datos y plataformas de gestión de aprendizaje en la universidad del Valle, Colombia. *Revista de Investigación, Desarrollo e Innovación, 9*(2), 303-317.

Difabio, H.E., & Álvarez, G. (2020). Perfil del estudiante y desempeño en actividades virtuales de retroalimentación entre pares en torno a capítulos de tesis de posgrado. *Tendencias Pedagógicas, 36,* 26-43. https://dialnet.unirioja.es/servlet/articulo?codigo=7615111

Espinoza, N., & Miguel, V. (2021). Análisis de la práctica reflexiva de docentes universitarios en portafolios digitales. *Areté: Revista Digital del Doctorado en Educación de la Universidad Central de Venezuela*, *7*(13), 141-166. http://saber.ucv.ve/ojs/index.php/rev_arete/article/view/21332

Fernando, S. M., & García Martínez, A. (2016). Fundamentos del aprendizaje en red desde el conectivismo y la teoría de la actividad. *Revista Cubana de Educación Superior, 35*(3), 98-112. http://scielo.sld.cu/scielo.php?pid=S0257-43142016000300008&script=sci_arttext&tlng=pt

George Reyes, C. E., & Salado Rodríguez, L. I. (2018). Competencias investigativas con el uso de las TIC en estudiantes de doctorado. *Apertura (Guadalajara, Jal.), 11*(1), 40-55. https://doi.org/10.32870/ap.v11n1.1387

González Torres, A. (2021). Percepción estudiantil de un curso universitario que integró los recursos de Google como apoyo educativo. *RIDE. Revista Iberoamericana para la Investigación y el Desarrollo Educativo, 11*(22). https://doi.org/10.23913/ride.v11i22.962

Hernández, R., & Mendoza, C.P. (2018). *Metodología de la Investigación. Las rutas cuantitativa, cualitativa y mixta*. McGraw-Hill Interamericana Editores.

Instituto de Estadística de la Unesco (2013). *Uso de TIC en Educación en América Latina y el Caribe.* https://unesdoc.unesco.org/ark:/48223/pf0000219369

Latorre, A. (2005). *La investigación-acción. Conocer y cambiar la práctica educativa*. Editorial Graó.

Massola, G. (2021). WhatsApp, Google Drive e mapa conceitual: algumas possibilidades com uso de dispositivos digitais para promover inclusão digital e autonomia da aprendizagem para a Educação Técnica Integrada ao Ensino Médio. *Brazilian Journal Development, 7*(3), 31090-31105. https://brazilianjournals.com/index.php/BRJD/article/view/27120

Medina-Sánchez, Y., Ferrer, M., & Pérez, N. (2021). La gestión del aprendizaje como herramienta formativa en el sistema educacional cubano actual. *Maestro y Sociedad, 18*(2), 802-814. https://maestroysociedad.uo.edu.cu/index.php/MyS/article/view/5376

Montano, F. D. (2021). Evaluation digital of tolos for the management the portafolio educational. *Minerva, 2*(4), 55-61. https://doi.org/10.47460/minerva.v2i4.27

Murillo Sancho, G. (2012). El portafolio como instrumento clave para la evaluación en educación superior. *Revista Electrónica Actualidades Investigativas en Educación, 12*(1), 1-23. https://www.redalyc.org/pdf/447/44723363015.pdf

Peña, C. I., & Barragán, I. C. (2022). *El portafolio digital como tecnología mediadora del proceso de enseñanza-aprendizaje y la gestión de información y del conocimiento en educación superior*. Universidad Unab. http://hdl.handle.net/20.500.12749/16431

Rodríguez Espinosa, H., Restrepo Betancur, L., & Aranzazu, D. (2014). Alfabetización informática y uso de sistemas de gestión del aprendizaje en la docencia universitaria. *Revista de la Educación Superior, 43*(171), 139-159. https://doi.org/10.1016/j.resu.2015.03.004

Ruiz, R. H., Juárez, M. D. R. I. P., & Morales, E. A. (2016). Gestión del aprendizaje: referente innovador para la formación de académicos en la Universidad Veracruzana. *II Congreso Internacional de Educación Superior,* Chiapas, México. https://www.uv.mx/dgdaie/files/2013/04/x4-referente-innovador.pdf

Salazar Mercado, S. A., & Arévalo Duarte, M. A. (2019). Implementación del portafolio como herramienta didáctica en educación superior: revisión de literatura. *Revista Complutense de Educacion, 30*(4), 965-981. https://dx.doi.org/10.5209/rced.59868

Sánchez, I.R. (2016). La sociedad de la información, sociedad del conocimiento y sociedad del aprendizaje. Referentes en torno a su formación. *Bibliotecas Anales de Investigación, 12*(12), 231-239. http://revistas.bnjm.sld.cu/index.php/BAI/article/view/179/189

Soubal, S. (2008). La gestión del aprendizaje. *Polis Revista Latinoamericana, 7*(21), 311-337. https://scielo.conicyt.cl/pdf/polis/v7n21/art15.pdf

Tipán, D., Jordán, N., & Tipán, H. (2021). Portafolio digital interactivo para la autoevaluación integral. *Revista de divulgación científica de la Universidad Alas Peruanas, 8*(2), 43-57. http://dx.doi.org/10.21503/hamu.v8i2.2289

Universitat Oberta de Catalunya (UOC). (2023*). Transformación digital universitaria: Informe regional América Latina.* https://acortar.link/aGGOsB

Ureta, L., & Rossetti Beiram, G. (2020). Las TAC en la construcción de conocimiento disciplinar: una experiencia de aprendizaje con estudiantes universitarios. *Revista Iberoamericana de Tecnología en Educación y Educación en Tecnología, 26*, 100-109. https://doi.org/10.24215/18509959.26.e11

Valverde-Berrocoso, J., Revuelta Domínguez, F. I., & Fernández Sánchez, M. R. (2012). Modelos de evaluación por competencias a través de un sistema de gestión de aprendizaje. *Revista Iberoamericana de Educación, 60,* 51-62. https://doi.org/10.35362/rie600443

Vidal Ledo, M. J., Rodríguez Dopico, R. M., & Martínez Hernández, G. (2014). Sistemas de gestión del aprendizaje. *Educación Médica Superior, 28*(3), 602-614. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-21412014000300019

Zapata, M. (2003). Sistemas de gestión del aprendizaje – Plataformas de teleformación. *Revista de Educación a Distancia, 3*, 1-48. https://revistas.um.es/red/article/view/25661/24891

Check for updates

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.11

Cómo citar:
Kulikova, S., Iastrebova, V., Kichuk, N., Kemin, V., & Zhulkanych, B. (2024). The influence of sociocultural activities on building social competencies. *Revista Eduweb*, *18*(4), 165-176. https://doi.org/10.46502/issn.1856-7576/2024.18.04.11

The influence of sociocultural activities on building social competencies

La influencia de las actividades socioculturales en el desarrollo de las competencias sociales

Svitlana Kulikova
https://orcid.org/0000-0003-0397-6853
arzu.hadciyeva@gmail.com
Volodymyr Vynnychenko Central Ukrainian State University, Associate Professor of the Department of Art Education, Department of Pedagogy, Psychology and Arts, Kropyvnytskyi, Ukraine.

Vira Iastrebova
https://orcid.org/0000-0002-0757-2090
vira.yastrebova@gmail.com
National University "Odesa Law Academy", Odessa, Ukraine.

Nadiya Kichuk
https://orcid.org/0000-0002-5963-7802
kichuk.n.86@gmail.com
Izmail State University of Humanities, Professor of the Department of Preschool and Primary Education, Izmail, Ukraine.

Volodymyr Kemin
https://orcid.org/0000-0002-1372-7968
kemin.volodymyr74@gmail.com
Drohobych Ivan Franko State Pedagogical University, Professor of the Department of English Language Practice and Methodology of its Teaching, Drohobych, Ukraine.

Borys Zhulkanych
https://orcid.org/0009-0003-4008-1028
b.zhulkanich@uzhnu.edu.ua
State Higher Educational Institution "Uzhhorod National University", Senior Lecturer of the Department of Physical Geography and Rational Nature Management, Uzhgorod, Ukraine.

Recibido: 02/11/24
Aceptado: 22/12/24

Abstract

The aim of the article is to track the dynamics of the development of citizens' social competencies in the context of specially organized socio-cultural activities. The method of V.V. Sinyavskyi and B.A. Fedoryshyn was used to determine the development of communicative and organizational abilities, as well as the method of N. Hall to study emotional intelligence (EI). It was found that, in general, medium indicators of social competencies are characteristic of the studied citizens. The developed programme of socio-cultural influence showed effectiveness in the dynamics of communicative abilities. However, the changes turned out to be more significant in the students' sample. The indicators of organizational abilities as a result of

the formative experiment remained unchanged. El significantly changed in the group of working citizens after completing the programme, while the indicators remained stable among students. The results indicate the partial effectiveness of the programme of socio-cultural activities in the development of social competencies of the citizens of Ukraine. The obtained data make it possible to optimize the strategy of educational influence in the student environment with a focus on the cultural integration of the individual. The data can also be used to develop communication trainings for specialists of certain organizations. Research prospects are to clarify gender differences in the influence of socio-cultural activities on the development of citizens' social competencies.

Keywords: communication skills, emotional intelligence (EI), organizational skills, social competencies, socio-cultural activity**.**

Resumen

El objetivo del artículo es seguir la dinámica del desarrollo de las competencias sociales de los ciudadanos en el contexto de actividades socioculturales especialmente organizadas. Se utilizó el método de V.V. Sinyavskyi y B.A. Fedoryshyn para determinar el desarrollo de las capacidades comunicativas y organizativas, así como el método de N. Hall para estudiar la inteligencia emocional (IE). Se comprobó que, en general, los indicadores medios de competencias sociales son característicos de los ciudadanos estudiados. El programa desarrollado de influencia sociocultural mostró eficacia en la dinámica de las habilidades comunicativas. Sin embargo, los cambios resultaron ser más significativos en la muestra de estudiantes. Los indicadores de las habilidades organizativas como resultado del experimento formativo permanecieron inalterados. La IE cambió significativamente en el grupo de ciudadanos trabajadores tras completar el programa, mientras que los indicadores permanecieron estables entre los estudiantes. Los resultados indican la eficacia parcial del programa de actividades socioculturales en el desarrollo de las competencias sociales de los ciudadanos de Ucrania. Los datos obtenidos permiten optimizar la estrategia de influencia educativa en el entorno estudiantil centrándose en la integración cultural del individuo. Los datos también pueden utilizarse para desarrollar cursos de formación en comunicación para especialistas de determinadas organizaciones. Las perspectivas de investigación consisten en aclarar las diferencias de género en la influencia de las actividades socioculturales en el desarrollo de las competencias sociales de los ciudadanos.

Palabras clave: actividad sociocultural, competencias sociales, habilidades comunicativas, habilidades organizativas, inteligencia emocional (IE).

Introduction

Preservation of the cultural heritage of humanity and the state plays an important role in overcoming poverty, ensuring gender equality and solving environmental problems (Giliberto & Labadi, 2021; Wiktor-Mach, 2019). Active sociocultural activity ensures the formation of identity and competitiveness of the local communities (Lopes & Hiray, 2024). The importance of socio-cultural activities for the implementation of sustainable development processes is argued (Mair & Smith, 2021). An important direction of research is the study of the cultural influences in the tourism sector and economic trends (Wallstam et al., 2018). In particular, the role of cultural festivals as centres of concentration of tangible and intangible resources, which give a powerful impetus to urban development (Perry et al., 2019), as well as economic and social development in general (Luonila et al., 2020), is growing. In this context, the relevance of the academic analysis and creation of a theoretical model of socio-cultural activities as part of state policy is increasing (Nordvall & Brown, 2018). A club as a form of organization of socio-cultural activities has been proven an effective tool for the cognitive, social, and professional development of citizens (Nunev, 2019). In general, the tendency of studying the general aspects of involvement in the cultural space can be traced, while the analysis of specific empirical data regarding the specified processes remains insufficient.

In this context, the role of programmes of socio-cultural activities for the formation of social competencies

is worth noting. Communication skills are mandatory for the successful integration of an individual into the cultural and professional environment (Dauber & Spencer-Oatey, 2023). It is worth noting that the theoretical definition of social competencies is associated with a number of methodological problems in the search for a single definition (Beenen et al., 2023). Therefore, the theoretical and practical relevance of the study of the phenomenon of social competencies in the context of specific social conditions is obvious. It is promising to search for ways to develop social skills of an individual, in particular, through well-founded and purposeful programs of socio-cultural activities. It is important to have a differentiated approach, which provides for specific social categories of the population — students, workers in certain fields, etc.

The aim of the article is to determine the dynamics of the development of citizens' social competencies in the context of specially organized socio-cultural activities.
Objectives of the study:

1) Determine the main features and indicators of the influence of the socio-cultural sphere on the functioning of society;
2) Analyse the indicators of the development of communication skills, organizational skills, and EI of citizens;
3) Empirically determine the indicators of the development of social competencies of student youth and working adults in the context of organized socio-cultural activities.

Literature Review

One of the first researchers of social competence, Rose-Krasnor (1997), describes this phenomenon as the ability for effective social interaction, optimal adaptation to communicative situations, and the construction of trusting relationships. This mental system provides for appropriate cognitive, emotional, and behavioural structures. It is emphasized that there are quite a lot of definitions of social competence and they may even contradict each other (Junge et al., 2020). Social competence implies a certain social flexibility, which involves differentiated behaviour in different communicative contexts and pronounced cultural differences (Pinquart, 2022). Accordingly, social competencies require orientation to three main aspects — the communicative goal, the content of communication, and the psychological characteristics of the participants in the interaction (Touloumakos, 2022). Rabetska (2022) believes that the main social competencies are the ability to understand interaction partners, effective communication tools (verbal and non-verbal), the ability to optimally resolve interpersonal conflicts, empathy, emotional self-regulation. The factor model underlying the appropriate diagnostic tool predicts the following types of social competencies: leadership ability, group integration, interpersonal communication and affiliation skills, social activity (Padhy & Hariharan, 2023). A significant social competence of humanitarian workers is the ability to work in a team (Febrianita & Hardjati, 2019). The results of empirical studies indicate the importance of empathy in the structure of social competencies of secondary school graduates (Hirn et al., 2018).

Sociocultural influence depends on the coherence of two value systems – social and individual (Horban et al., 2022). The researchers claim that modern mass culture determines the emergence of a number of crisis phenomena in the citizens' minds associated with the development of the so-called "consumer society" (Zhylin et al., 2023). Such trends determine the need to develop clear conceptual foundations of the state's socio-cultural activities. The definition of the phenomenon involves a number of terminological interpretations. However, in general, sociocultural activity can be interpreted as a purposeful, specially organized by social institutions process of active involvement of a person in the cultural values of society and the active inclusion of the individual in it, which involves the development of the individual (Leshchuk & Soroka, 2020). It is believed that participation in sociocultural activities of an individual is related to the level of his/her subjective well-being (Murtin & Zanobetti, 2024).

The effectiveness of cultural processes primarily depends on the systemic activity of the state and specific social groups (Ginzarly et al., 2019). Socio-cultural activity is closely related to the concept of "cultural heritage". This concept reflects a cultural process that ensures the constant transfer of social memory, establishing connections between the cultural past and the present, which is associated with social,

political, and economic factors (Heras et al., 2019). Self-organization of a specific social community is essential for the described phenomenon (Pastor Pérez & Colomer, 2023). An approach that provides for active involvement of young people in the translation of cultural heritage is promising in theoretical and practical contexts (Zhang et al., 2023). The optimal organization of socio-cultural activities contributes to the formation of the valuable aspect of humanitarian security of the state (Giovanis, 2021).

Therefore, the study of the socio-cultural sphere and its influence on social processes is an actual vector of modern research. The study of social competencies and the development of the communicative sphere opens up prospects for the clarification of theoretical constructions and the development of effective socialization optimization programmes. However, the impact of purposeful socio-cultural activities on the development of communication skills of an individual is poorly studied, which causes certain gaps.

Methodology

The general structure of the study corresponds to the provisions of the natural science paradigm. Different stages of the research reflect the relationship and logical sequence of actions of the researchers. The general scheme of the research was analysed in detail before carrying out it in order to obtain valid academic results.

1. The organizational stage is an algorithm of actions that substantiates the general research design and ensures the fulfilment of the research objectives in the context of clarifying the impact of socio-cultural activities on the development of citizens' social competencies. The formative strategy was defined as the main one in our study. A system of classes in the field of socio-cultural activities aimed at the development of social competencies was developed. Intensive consultations with experts — psychologists, teachers, specialists in the cultural sphere — were also involved. Research samples were formed on the basis of scientific, psychological, and ethical criteria. The most effective ways of experimental influence and collection of the data on the dynamics of social effectiveness of the individual were established. The main parameters reflecting key social competencies were chosen: communicative skills as the ability to communicate effectively; organizational skills as the ability to effectively organize and coordinate social interaction; EI as the ability to identify and understand emotions in social processes. The research hypothesis is advanced: a specially organized purposeful methodologically justified programme of socio-cultural activities is an effective tool for building social competencies of citizens of Ukraine. The stage comprised the period of September-October 2023.
2. Experimental stage — collection of research data and formative experiment. The stage was carried out according to the classic scheme: primary diagnostics of social competence development indicators, formative influence, repeated diagnostics of social competence development indicators. This stage was conducted online because of the security situation in Ukraine and in order to ensure mobility and representativeness of the study. The proposed approach made it possible to realize a fairly wide geography of the studied sample. If necessary, citizens could refuse to participate in the experimental programme. All actions of the empirical stage met the basic ethical criteria. The stage comprised the period of November 2023 — April 2024.
3. The stage of quantitative and qualitative data processing. Primary diagnostic individual data "before" and "after" the implementation of the experimental programme were calculated. Measurement scales, their types, compliance of the obtained data with the law of normal distribution were determined. The procedure for calculating the statistical significance of the differences in the obtained results was carried out. The stage comprised the period of May — June 2024.
4. The data interpretation stage involved the explanation of statistical patterns in the context of the aim of the study. The main task of the stage was to draw a conclusion about the effectiveness of the programme of socio-cultural activities for building social competencies of citizens of Ukraine. The generalization was carried out with the orientation of the difference in indicators in the context of different categories — those who are getting an education and working citizens of the state.

Instruments

The aim of the research was achieved by selecting test methods in terms of their convenience and mobility. The method of V. V. Sinyavskyi and B. A. Fedoryshin was used to determine the indicators of communicative and organizational abilities. Hall's method was applied in order to study EI as one of the key social competencies. The selected methods are recommended for psychological research of the communicative structure of the personality (Kokun et al., 2012). The selected tests meet psychometric requirements, which is confirmed by expert opinion and their methodical and academic argumentation in other studies. The methods are quite compact in scope, which enables avoiding over-fatigue of research participants in the process of working out the test content.

Sample

Two samples were formed according to the natural science paradigm — experimental group (EG) and control group (CG). Students and working citizens from various educational institutions and organizations of Ukraine took part in the study. The student samples included graduates from higher education institutions (HEIs) from Kyiv, Sumy, Ivano-Frankivsk, Cherkasy, and Odesa. The study involved 109 students of the CG and 111 students of the EG (a total of 220 people). Gender distribution of the studied students: 96 boys (43.64%) and 124 girls (56.36%). Two samples consisting of teachers, doctors, lawyers, and service workers were also formed. Quantitative distribution of this group: 69 people in the CG and 70 in the EG (total number – 139 people). Accordingly, the gender distribution was: 102 women (73.38%) and 37 men (26.62%). The samples were formed on the basis of personal contacts of researchers with educational institutions and organizations, as well as the use of social networks to establish communication. Only adults participated in the study based on prior informed consent.

Data analysis

The data were collected online using test instruments via Google forms. Qualified specialists in the field of psychology who have experience in practical and research activities were also involved. The tests were methodologically and professionally justified.

The description of the programme of experimental influence deserves special attention. This system was based on a number of socio-cultural measures. The main principles on which the programme was based were cultural relevance, humanism, individual approach, unity of activity with specific cultural traditions (Leshchuk, 2019). The number of meetings was not fixed and ranged from 18 to 20 — an average of two meetings per week. The meetings were held online. The duration of one lesson is 50 minutes. Each experimental community was divided into subgroups of 15–20 participants each. The main thematic blocks of the programme: cultural heritage of Ukraine and its connection with world trends, cultural heritage of the region and its connection with state and world trends. Each of these blocks included approximate topics: literature, painting, cinematography, music, prominent statesmen. We emphasize that the list of topics is not fixed, but dynamically changed depending on the mood in the group and the interests of the subjects. At each session, the researcher offered information on a certain aspect of cultural heritage, followed by creative reflection of the material (for example, preparation of essays, creation of mini-scenarios, thematic sketches, etc.) and discussion. The meeting necessarily ended with summing up. The implementation of the experimental programme was carried out by the authors of the study and their assistants. Formative experiment is conducted in the EG, while the programme was not implemented in the CG.

The data analysis is aimed at determining statistical indicators of the dynamics of the social competencies of the subjects during the experimental programme. The identified trends are presented graphically. Basic statistical methods: Kolmogorov-Smirnov test, Student's t-test. In this way, the statistical significance of the differences in the identified empirical indicators was established. Data processing was carried out in the SPSS software package.

Results and Discussion

The results of the conducted formative experiment in terms of the dynamics of social competencies are graphically presented in the diagrams. The abbreviations CG and EG represent the control and experimental groups, respectively. The letter “S” is indicated in the samples of students, and the letter “W” in the samples of working citizens. Figures 1 and 2 indicate the results of primary and secondary diagnostics (before and after the completion of the sociocultural programme). The dynamics of communicative skills in the studied samples is recorded in Figure 1.

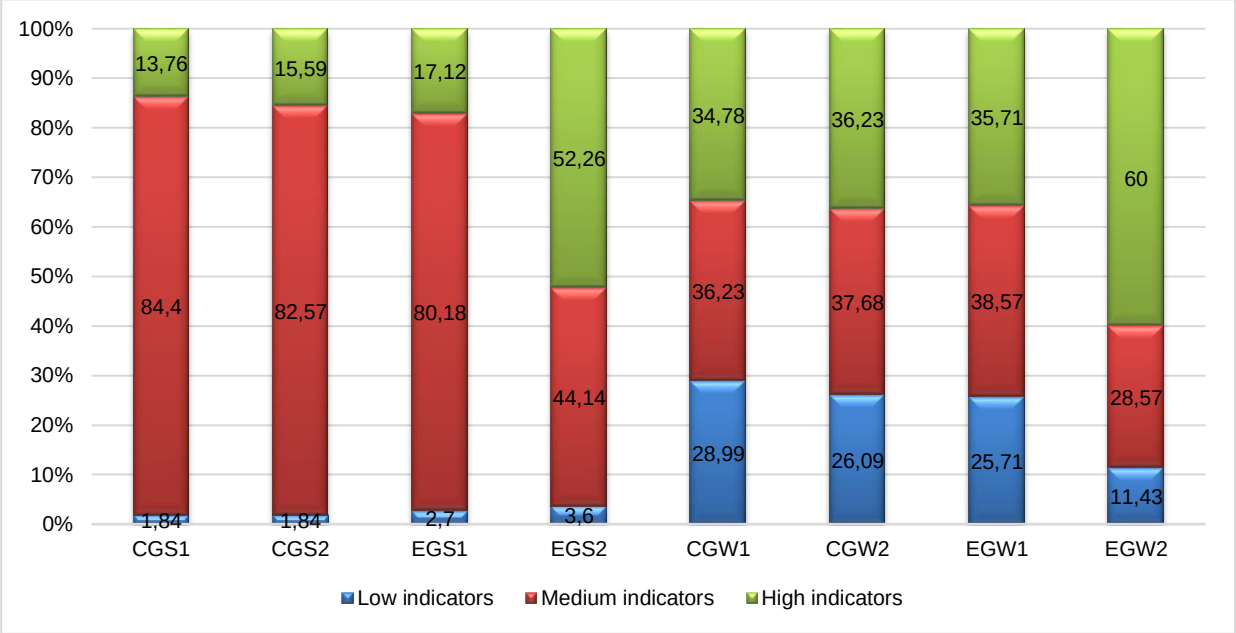

Figure 1. Dynamics of indicators of communicative skills during the implementation of the programme of socio-cultural activities.

In the students’ sample, the primary diagnostics showed a significant predominance of individuals with medium values of the parameter — more than 80%. Low communication skills were diagnosed in only a few students at the beginning of the study. The percentage values of a high level of this social competence range within 13-17%. The obtained data potentially indicate some instability of the ability to communicate among student youth. After completing the sociocultural programme, no significant changes were found in the CG of students. At the same time, a significant increase in the percentage of subjects with high indicators (by 35.14%) in the EG attracts attention. The overall medium level is decreasing. In the sample of working citizens, the primary diagnostics recorded that the levels of the parameter of the subjects were distributed almost in equal thirds. The investigated social competence of workers has higher high and low indicators compared to the group of students. After the completion of the experimental programme, the percentage of persons with high indicators of communicative skills increased by 24.29%. The medium indicators of competence decreased by 10%, and the low ones — by 14.28%. Therefore, it is possible to conclude about the effectiveness of the developed socio-cultural programme for the development of the ability to effective communication. The dynamics of organizational abilities in the studied samples is shown in Figure 2.

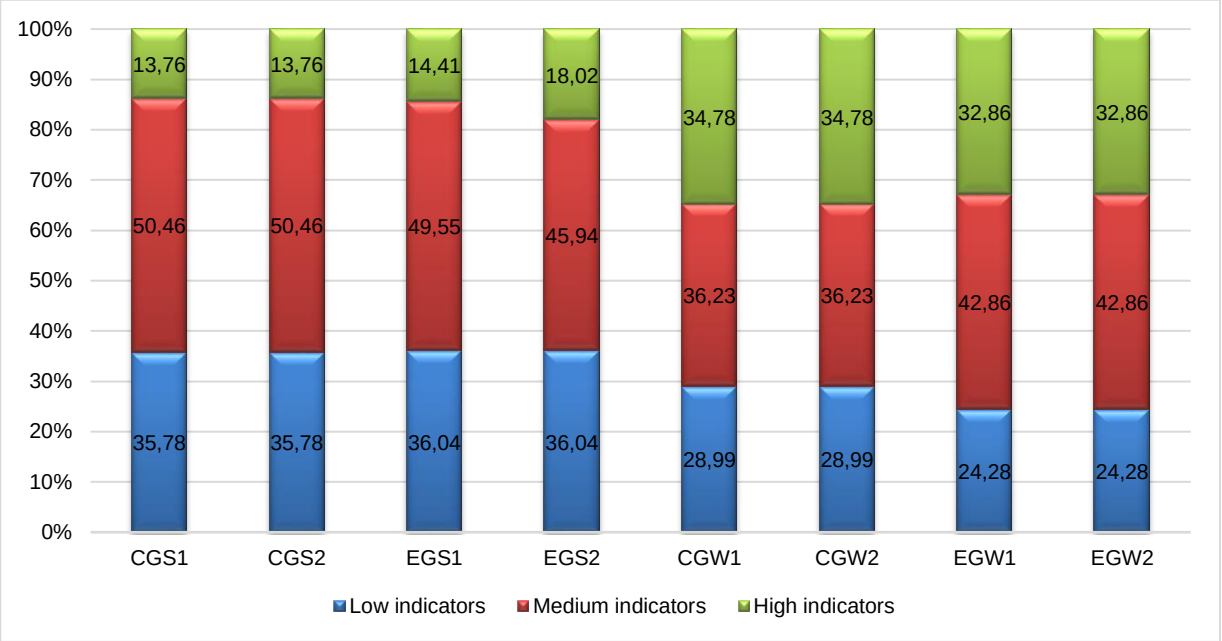

Figure 2. The dynamics of indicators of organizational abilities during the implementation of the programme of socio-cultural activities.

In the group of students, the dominance of medium indicators of social competence was revealed again. However, organizational abilities are less developed than communicative ones. This is evidenced by more than 30% of the respondents diagnosed with low indicators of the parameter. A small number of studied students have a high level. After the implementation of the programme of socio-cultural activities, the indicators in both samples did not actually change. In the sample of working citizens, the distribution of diagnostic levels in equal thirds was observed again. We can assume that communicative and organizational tendencies are more interconnected in adulthood, compared to the sample of student youth. Re-diagnosis did not reveal significant changes. Therefore, the programme of socio-cultural activities is not effective for organizational competence. The dynamics of EI in the studied samples is shown in Figure 3.

The tendency of dominance of medium indicators continues for this parameter. In the sample of students, the medium level was found in approximately 60% of the subjects. The percentage of the high level is slightly higher than the indicators of the low level. In the group of students, the developed socio-cultural programme did not demonstrate effectiveness for the development of EI. It should be noted that the indicators of this social competence have similar trends in the groups of students and workers. However, a minimum number of people with a low level of EI was found in the sample of workers. No changes were found in the CG. In the EG of working citizens, a significant increase in the percentage of high indicators was recorded — by 51.43%. So, the developed programme of socio-cultural activities demonstrated partial effectiveness in the EI development.

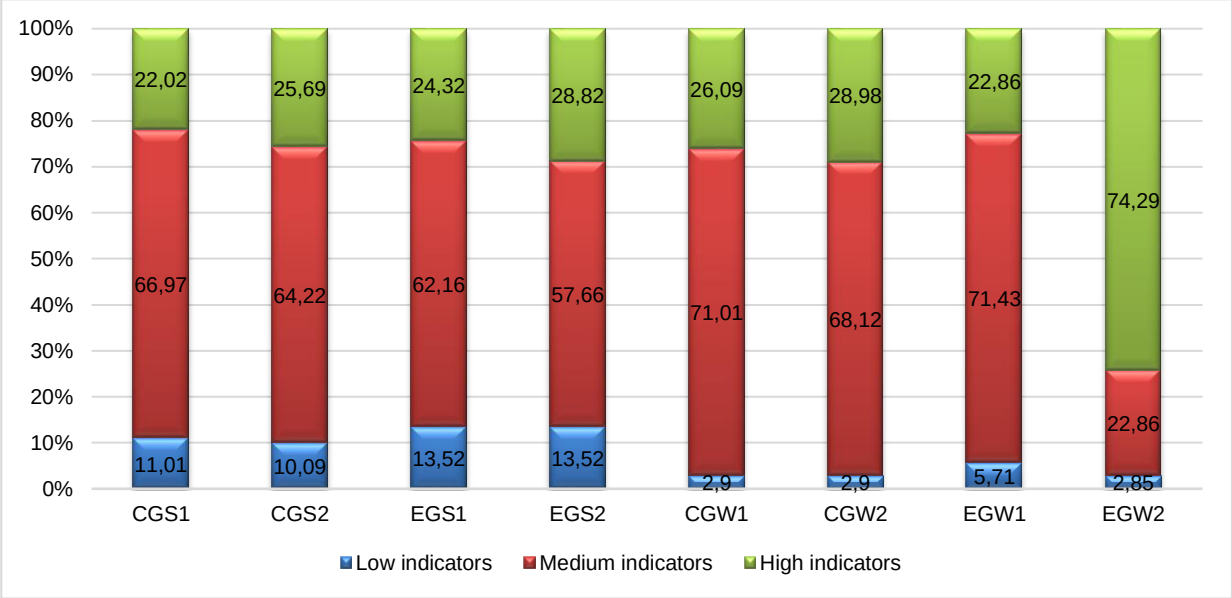

Figure 3. Dynamics of indicators of EI during the implementation of the programme of socio-cultural activities.

The use of the Kolmogorov-Smirnov test confirmed the correspondence of the series of statistical data to the law of normal distribution. The results of the descriptive analysis were confirmed by using Student's t-test to reveal the significance of the differences between the obtained statistical data "before" and "after" the formative experiment (Table 1). It was found that all obtained coefficients for the two control groups do not reflect a significant difference between the indicators of social competencies. In the EG of students, significant changes in the parameter of communicative skills were recorded (t=4.337, p=0.01). In the experimental sample of working citizens, significant differences were determined in the dynamics of communicative skills (t=2.357, p=0.05) and EI (t=3.269, p=0.01). In general, the results of the conducted statistical analysis confirm the previous conclusions.

Table 1.
The Student's t-test of differences in indicators of social competencies in the context of a formative experiment

Social competencies	**Student's t-test**			
	Sample of students		Sample of working youth	
	CG	EG	CG	EG
Communication skills	1.722	4.337**	1.449	2.357*
Organizational abilities	1.301	1.098	1.567	1.386
EI	1.222	1.301	1.663	3.269**

Observing the behaviour of research participants during the formative experiment makes it possible to make several generalizations. In general, working citizens were more oriented towards cooperation and an active position in the programme compared to students. In particular, it was indicative that the students performed "homework" reading certain books or watching movies for further discussion less responsibly. At the same time, there was a clear tendency to more active participation in thematic discussions and creative activities during the implementation of the programme. The main topic of the discussions was based on a specific object of socio-cultural heritage that was considered at the meeting. So, the result of communication was influenced by awareness and training on a specific topic. Several main types of participants in the socio-cultural programme can be tentatively identified.

The first type is “supporters of arguments”, who implement a discussion based on a thorough study of the subject. They focus more on facts rather than emotions. They do not switch to manipulative aspects in communication. They remain calm during the discussion being friendly in interaction. They can prove an opinion regardless of personal socio-cultural preferences. About 70% of the participants of this orientation were found in the group of working citizens and about 40% in the sample of students.

The second type is “supporters of emotions”, who engage in communication based on the actualization of the emotional component. Prone to provoking conflicts. They use elements of manipulation and passive aggression. They can switch to an active manifestation of aggression. About 20% of such participants were found in the group of working citizens and about 30% in the students’ sample.

The third type is “indifferent”, who take the most passive position in the communicative space of the programme. Minimal activity in discussions is characteristic. Communication is unargued. They can leave the communication that has already started. About 10% of such participants were found in the group of working citizens and about 30% — among students.

It should be noted that the division by types took place on the basis of observation, so it does not claim to be accurate. However, the identified differences can be the basis for planning and developing an individual approach in development programmes. In general, we evaluate the programme of socio-cultural activities as one that was quite positively perceived by the research participants.

The generalized research hypothesis is the statement that a specially organized, purposeful, methodologically sound programme of socio-cultural activities is an effective tool for building social competencies of citizens of Ukraine. In general, the results indicate its partial confirmation. The predominance of medium indicators of social competencies is explained by the potential instability of the communicative sphere of the individual. Differences in primary diagnostics between students and working citizens are related to different social conditions of activity and age-related aspects of personality development. In addition, the impact of the tense general situation in the country because of the war should be taken into account. The effectiveness of the programme of socio-cultural activities for building communication skills can be explained by the active use of the discussion method in the context of cultural topics. At the same time, organizational abilities did not show developmental shifts, as the content and implementation method of the programme itself were not sensitive to this structure. The lack of effectiveness of the programme for EI development of higher school students is related to their greater passivity, compared to the group of working people. Progress in EI during the programme may be associated with greater social engagement in the experimental community. At the same time, the increased passive aggression and closed position of students hindered the activation of EI.

In the context of the goal and objectives of the study, we support the opinion about the importance of socio-cultural activities for the development of society (Mair & Smith, 2021). Studying the influence of cultural development on the optimization of the economic sphere also seems promising (Luonila et al., 2020). In this context, it is important to organize a systemic state policy to address this issue (Ginzarly et al., 2019). The club form of organizing sociocultural influence is quite effective, especially in educational systems (Nunev, 2019). It is important to focus sociocultural activities on personality development (Leshchuk & Soroka, 2020). This approach makes it possible to optimize the citizens’ psychological well-being (Murtin & Zanobetti, 2024). The optimal organization of socio-cultural activities contributes to the formation of the valuable aspect of humanitarian security of the state (Giovanis, 2021).

We explain the high values of social competencies of working citizens by their relevance for the integration of the individual into the professional environment (Dauber & Spencer-Oatey, 2023). The results of observing the subjects during the experiment confirm the opinion about the importance of social flexibility for effective social interaction (Pinquart, 2022). Empathy is also an important component of the communicative sphere (Hirn et al., 2018).

Limitations

The obtained results should be evaluated through the prism of several factors. First, the diagnostics and collection of empirical material were conducted online, therefore it is advisable to determine the specifics of the actions performed in direct interaction. Differences in the quantitative and gender composition of samples of students and working citizens should also be taken into account. The results could also be affected by stress reactions, instability of the emotional sphere due to the military situation in Ukraine.

Recommendations

The obtained data give ground give grounds to provide the following recommendations for optimizing socio-cultural activities and building the social competencies of students:

1) Introduce discussion forms of work into students' educational activities;
2) Develop and implement courses on the study of regional and state cultural heritage into educational programmes;
3) Teach students the algorithms of argumentation of their own opinion;
4) Stimulate interest in cultural heritage in the context of main educational subjects;
5) Provide the possibility of individual work on the subject in the context of the activation of socio-cultural activities in the plans.

Conclusions

The influence of socio-cultural activities on the development of social competencies was not the subject of the research. The practical significance of the study of this problem is the possibility of effective influence on the transformation of the cultural environment and the development of the individual. It was found that, in general, medium indicators of the development of social competences are characteristic of the studied citizens. It was found that in the group of working citizens, indicators of high, medium and low levels of communicative and organizational abilities were evenly distributed. At the same time, the medium values for these parameters significantly prevail in the students' sample. The trends in the manifestation of EI are similar in both groups. The developed programme of socio-cultural influence showed effectiveness in the dynamics of communicative abilities. However, in the students' sample, the changes turned out to be more significant. Indicators of organizational abilities as a result of the implementation of the formative experiment remained unchanged. EI significantly changed in the group of working citizens after completing the programme, while the indicators remained stable among students. The results indicate the partial effectiveness of the programme of socio-cultural activities in the development of social competencies of citizens of Ukraine. The obtained data make it possible to optimize the strategy of educational influence in the student environment with a focus on the cultural integration of the individual. The data can also be used to develop communication trainings for specialists of certain organizations. Further research may focus on clarifying gender differences in the influence of socio-cultural activities on the development of citizens' social competencies.

Bibliographic references

Beenen, G., Fiori, M., Pichler, S., & Riggio, R. (2023). Editorial: Interpersonal Skills: Individual, Social, and Technological Implications. *Frontiers in Psychology, 16*(14), 1209508. https://doi.org/10.3389/fpsyg.2023.1209508

Dauber, D., & Spencer-Oatey, H. (2023). Global Communication Skills: Contextual Factors Fostering Their Development at Internationalised Higher Education Institutions. *Studies in Higher Education, 48*(7), 1082-1096. https://doi.org/10.1080/03075079.2023.2182874

Febrianita, R., & Hardjati, S. (2019). The Power of Interpersonal Communication Skill in Enhancing Service Provision. *Journal of Social Science Research*, *14*, 3192-3199. https://doi.org/10.24297/jssr.v14i0.8150

Giliberto, F., & Labadi, S. (2021). Harnessing cultural heritage for sustainable development: an analysis of three internationally funded projects in MENA Countries. *International Journal of Heritage Studies*, *28*(2), 133-146. https://doi.org/10.1080/13527258.2021.1950026

Ginzarly, M., Houbart, C., & Teller, J. (2019). The Historic Urban Landscape Approach to Urban Management: A Systematic Review. *International Journal of Heritage Studies, 25*(10), 999-1019. https://doi.org/10.1080/13527258.2018.1552615

Giovanis, E. (2021). Participation in Socio-Cultural Activities and Subjective Well-Being of Natives and Migrants: Evidence from Germany and the UK. *International Review of Economics, 68*, 423-463. https://doi.org/10.1007/s12232-021-00377-x

Heras, V. C., Soledad Moscoso Cordero, M., Wijffels, A. Tenze, A., & Esteban Jaramillo Paredes, D. (2019). Heritage Values: Towards a Holistic and Participatory Management Approach. *Journal of Cultural Heritage Management and Sustainable Development, 9*(2), 199-211. https://doi.org/10.1108/JCHMSD-10-2017-0070

Hirn, S. L., Thomas, J., & Zoelch, C. (2018). The Role of Empathy in the Development of Social Competence: A Study of German School Leavers. *International Journal of Adolescence and Youth, 24*(4), 395-407. https://doi.org/10.1080/02673843.2018.1548361

Horban, O., Protsenko, O., Tytarenko, V., Bulvinska, O., & Melnychenko, O. (2022). Cultural Economics: The Role of Higher Education Institution in Shaping the Value Systems. *Scientific Bulletin of the National Mining University, 1*, 128-132. https://doi.org/10.33271/nvngu/2022-1/128

Junge, C., Valkenburg, P. M., Deković, M., & Branje, S. (2020). The Building Blocks of Social Competence: Contributions of the Consortium of Individual Development. *Developmental Cognitive Neuroscience, 45*, 100861. https://doi.org/10.1016/j.dcn.2020.100861

Kokun, O. M., Pishko, I. O., Lozinska, N. S., Kopanytsia,O. V., Herasymenko, M. V., & Tkachenko, V. V. (2012). *Collection of methods of diagnostics of leadership qualities of cadet, sergeant and officer staff: Methodical manual.* Research Center for Humanitarian Issues of the Armed Forces of Ukraine. https://lib.iitta.gov.ua/11156/1/Діагностика%20лідер_якостей.pdf

Leshchuk, H. V. (2019). Features of Socio-Cultural Activity as a Factor of Social-Educational Influence on Personality. *Scientific Bulletin of Uzhhorod University. Series: "Pedagogy. Social Work", 1*(44), 98-101. https://doi.org/10.24144/2524-0609.2019.44.98-101

Leshchuk, H., & Soroka, O. (2020). Socio-Cultural Activities and Inclusive Education: Points of Touch. *Scientific Bulletin of Uzhhorod University. Series: "Pedagogy. Social Work", 2*(47), 96-99. https://doi.org/10.24144/2524-0609.2020.47.96-99

Lopes, R., & Hiray, A. (2024). Impacts of Cultural Events and Festivals on Cultural Tourism. *Journal of Advanced Zoology, 45*(S4), 174-179. https://doi.org/10.53555/jaz.v45iS4.4177

Luonila, M., Kurlin, A., & Karttunen, S. (2020). Capturing Societal Impact: The Case of State-Funded Festivals in Finland. *Journal of Policy Research in Tourism, Leisure and Events, 13*(3), 397-418. https://doi.org/10.1080/19407963.2020.1839474

Mair, J., & Smith, A. (2021). Events and Sustainability: Why Making Events More Sustainable is Not Enough. *Journal of Sustainable Tourism, 29*(11-12), 1739-1755. https://doi.org/10.1080/09669582.2021.1942480

Murtin, F., & Zanobetti, L. (2024). The Art of Living Well: Cultural Participation and Well-Being. *Applied Research Quality Life*, 19, 1763–1790. https://doi.org/10.1007/s11482-024-10306-z

Nordvall, A., & Brown, S. (2018). Evaluating Publicly Supported Periodic Events: The Design of Credible, Usable and Effective Evaluation. *Journal of Policy Research in Tourism, Leisure and Events, 12*(2), 152-171. https://doi.org/10.1080/19407963.2018.1556672

Nunev, S. T. (2019). Club Forms of Activities and Creation of Educational Environment Promoting the Development of Social Work Students. *Social Work Education, 39*(3), 362-377. https://doi.org/10.1080/02615479.2019.1627309

Padhy, M., & Hariharan, M. (2023). Social Skill Measurement: Standardization of Scale. *Psychological Studies*, *68*, 114-123. https://doi.org/10.1007/s12646-022-00693-4

Pastor Pérez, A., & Colomer, L. (2023). Dissecting Authorised Participation in Cultural Heritage. *International Journal of Heritage Studies, 30*(2), 226-241. https://doi.org/10.1080/13527258.2023.2284741

Perry, B., Ager, L., & Sitas, R. (2019). Cultural Heritage Entanglements: Festivals as Integrative Sites for Sustainable Urban Development. *International Journal of Heritage Studies, 26*(6), 603-618. https://doi.org/10.1080/13527258.2019.1578987

Pinquart, M. (2022). Social Competence. In: Maggino, F. (eds) *Encyclopedia of Quality of Life and Well-Being Research*. Springer. https://doi.org/10.1007/978-3-319-69909-7_2741-2

Rabetska, N. L. (2022). Communicative Competence of Future Specialists in the Socio-Economic Sphere. *Academic Notes Series: Pedagogical Sciences*, *207*, 276-279. https://doi.org/10.36550/2415-7988-2022-1-207-276-279

Rose-Krasnor, L. (1997). The Nature of Social Competence: A Theoretical Review. *Social Development, 6*(1), 111-135. https://doi.org/10.1111/j.1467-9507.1997.tb00097.x

Touloumakos, A. K. (2022). Taking a Step Back to Move Forward: Understanding Communication Skills and Their Characteristics in the Workplace. *Studies in Continuing Education, 45*(2), 188-207. https://doi.org/10.1080/0158037X.2022.2030698

Wallstam, M., Ioannides, D., & Pettersson, R. (2018). Evaluating the Social Impacts of Events: In Search of Unified Indicators for Effective Policymaking. *Journal of Policy Research in Tourism, Leisure and Events, 12*(2), 122-141. https://doi.org/10.1080/19407963.2018.1515214

Wiktor-Mach, D. (2019). Cultural Heritage and Development: UNESCO's New Paradigm in a Changing Geopolitical Context. *Third World Quarterly, 40*(9), 1593-1612. https://doi.org/10.1080/0143659

Zhang, Y., Ikiz Kaya, D., van Wesemael, P., & Colenbrander, B. J. (2023). Youth Participation in Cultural Heritage Management: A Conceptual Framework. *International Journal of Heritage Studies, 30*(1), 56-80. https://doi.org/10.1080/13527258.2023.2275261

Zhylin, M., Maraieva, U., Krymets, L., Humeniuk, T., & Voronovska, L. (2023). Philosophy of Mass Culture and Consumer Society: Worldview Emphasis. *Amazonia Investiga, 12*(65), 256-264. https://doi.org/10.34069/AI/2023.65.05.24

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.12
Cómo citar:
Kyrychenko, T., Topchii, O., Ovcharenko, L., Kurinnyi, O., & Shcherbyna, Y. (2024). Adaptation of the communicative approach to teaching English in higher education. *Revista Eduweb*, *18*(4), 177-190. https://doi.org/10.46502/issn.1856-7576/2024.18.04.12

Adaptation of the communicative approach to teaching English in higher education

Adaptación del enfoque comunicativo a la enseñanza del inglés en la educación superior

Tetiana Kyrychenko
https://orcid.org/0000-0002-9160-2124
tetiana.n.1000@gmail.com
Department of Foreign Languages, Faculty of Biology and Technology, Sumy National Agrarian University, Sumy, Ukraine.
Oksana Topchii
https://orcid.org/0000-0002-0809-8730
topchii5557@gmail.com
Department of English Philology and Foreign Language Teaching Methods, Faculty of Foreign Languages, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine.
Liliia Ovcharenko
https://orcid.org/0000-0002-1868-5496
liliaovc44@gmail.com
Department of English Language Practices and Teaching Methods, Faculty of Ukrainian and Foreign Philology, Drohobych Ivan Franko State Pedagogical University, Drohobych, Ukraine.
Oleksii Kurinnyi
https://orcid.org/0000-0003-4518-2939
o.kurinnyi@gmail.com
Department of Foreign Languages, Faculty of Biology and Technology, Sumy National Agrarian University, Sumy, Ukraine.
Yuliia Shcherbyna
https://orcid.org/0000-0002-1646-0867
sherbina.y21@gmail.com
Department of Foreign Languages, Faculty of Biology and Technology, Sumy National Agrarian University, Sumy, Ukraine.

Recibido: 24/10/09
Aceptado: 25/12/03

Abstract

The article examines the effectiveness of adapting the communicative approach to teaching English in higher education. The aim of the study is to determine the impact of new methodologies on the development of students' communicative competencies. To achieve this goal, the following methods were used: surveys, testing, observation, and semi-structured interviews. Statistical analysis included the Levene's test, the Mann-Whitney test, ANOVA, and correlation analysis. The results showed a significant improvement in students' communicative skills: the average scores in grammar knowledge tests increased from 72.4 to 85.6 and lexical skills improved from 68.7 to 82.5. Other communicative skills also improved: speaking increased from 70.3 to 83.8 ($p < 0.01$) and listening improved from 65.2 to 80.1 ($p < 0.01$). The practical

significance of the results lies in the potential integration of communicative methods into curricula to enhance the quality of language education. Prospects for further research include evaluating the long-term effectiveness of the communicative approach and its adaptation to different forms of learning, including online and blended formats.

Keywords: academic achievement, communicative approach, communicative skills, English language teaching, higher education.

Resumen

El artículo examina la eficacia de la adaptación del enfoque comunicativo a la enseñanza del inglés en la educación superior. El objetivo del estudio es determinar el impacto de las nuevas metodologías en el desarrollo de las competencias comunicativas de los estudiantes. Para lograr este objetivo, se utilizaron los siguientes métodos: encuestas, pruebas, observación y entrevistas semiestructuradas. El análisis estadístico incluyó la prueba de Levene, la prueba de Mann-Whitney, ANOVA y análisis de correlación. Los resultados mostraron una mejora significativa en las habilidades comunicativas de los estudiantes: las puntuaciones medias en las pruebas de conocimientos gramaticales aumentaron de 72,4 a 85,6 y las habilidades léxicas mejoraron de 68,7 a 82,5. Otras habilidades comunicativas también mejoraron: la expresión oral aumentó de 70,3 a 83,8 ($p < 0,01$) y la comprensión auditiva mejoró de 65,2 a 80,1 ($p < 0,01$). La importancia práctica de los resultados radica en la posible integración de métodos comunicativos en los planes de estudio para mejorar la calidad de la enseñanza de idiomas. Las perspectivas de futuras investigaciones incluyen la evaluación de la eficacia a largo plazo del enfoque comunicativo y su adaptación a diferentes formas de aprendizaje, incluidos los formatos en línea y combinados.

Palabras clave: educación superior, enfoque comunicativo, enseñanza del idioma inglés, habilidades comunicativas, logro académico.

Introduction

In the modern world, the communicative approach to teaching English has become one of the most effective methodologies aimed at developing students' language skills. Its main goal is to create conditions that closely resemble real-life communication practice (Van Atteveldt et al., 2021). Given the growing demand for a high level of foreign language proficiency, especially in the context of globalization, adapting this approach to the higher education system is of particular relevance (Ali, 2019).

The challenges faced by higher education instructors include not only imparting theoretical knowledge but also developing students' ability to communicate effectively in English (Robert & Meenakshi, 2022; Slipetska et al., 2023). This requires consideration of the audience's age characteristics, preparation level, and the specifics of educational programs (Frumkina et al., 2020). In this context, the communicative approach ensures interactivity and active student participation in the learning process, contributing to a deeper understanding of the material (Thu, 2020).

Adapting the communicative approach to teaching in higher education requires modernizing traditional teaching methods such as lectures, written exercises, and translations (Seraj & Hadina, 2021). Instead, the focus should be on active forms of work: role-playing, discussions, project-based tasks that foster critical thinking and a creative approach to problem-solving (Castro & Villafuerte, 2019; Chen & Wu, 2023). This allows students not only to learn the language but also to develop sociocultural competence.

Particular attention should be given to creating a motivational environment that encourages students to actively use English as a means of communication (Namaziandost et al., 2019). In this context, the instructor's role is to create comfortable learning conditions where students are not afraid to make mistakes,

but where they have the opportunity to practice in real or near-real communication settings (Fandiño et al., 2019).

Thus, in the process of adapting the communicative approach to teaching English in higher education, it is essential to maintain a balance between theoretical knowledge and practical skills. This enables students not only to master the language but also to use it effectively for communication in various professional fields.

In the context of Ukraine, where English proficiency is increasingly valued as a gateway to global educational and professional opportunities, the adaptation of this approach to higher education is both timely and necessary (Konotop et al., 2021). However, the integration of communicative methods into the Ukrainian higher education system remains inconsistent, highlighting significant gaps in implementation.

Statistical data from recent surveys illustrate the urgency of improving English teaching methodologies in Ukraine. According to reports by the Ministry of Education and Science of Ukraine, only 42% of university graduates achieve the B2 level of English proficiency required for international academic and professional standards. Furthermore, a national survey conducted in 2022 revealed that 68% of students perceive traditional teaching methods, such as grammar-focused instruction and rote memorization, as insufficient for developing practical communication skills. These figures point to the need for a shift towards learner-centered, communicative methodologies that foster engagement and real-world language application.

The challenges in Ukraine's higher education system are compounded by resource constraints, such as outdated materials, insufficient teacher training in communicative techniques, and large class sizes that limit personalized instruction. Additionally, the regional disparities in access to quality language education exacerbate these issues, with rural institutions often lagging behind their urban counterparts in adopting modern teaching practices. Addressing these challenges requires a comprehensive approach to modernizing English language teaching, particularly through the adoption of innovative and interactive methodologies.

Existing literature highlights the effectiveness of the communicative approach in enhancing language proficiency, yet its application in Ukraine remains underexplored. Previous studies focus predominantly on general theoretical principles without delving into the specific challenges faced by Ukrainian educators and students. For example, while methods such as role-playing, group discussions, and project-based learning are widely advocated, there is limited empirical evidence on their impact within the unique sociocultural and educational landscape of Ukraine.

This study seeks to address these gaps by examining the effectiveness of adapting the communicative approach to the Ukrainian higher education context. It aims to provide practical insights into how this methodology can enhance students' communicative competencies and academic performance while fostering greater engagement and motivation to learn English. By focusing on the specific challenges and opportunities within Ukraine, this research contributes to a more nuanced understanding of effective language teaching practices in a globalized world.

The aim of the study is to determine the effectiveness of adapting the communicative approach to teaching English in higher education.

Research objectives:

1. To identify the level of students' communicative competencies before and after the implementation of the communicative approach.
2. To analyze the impact of communicative methodologies on students' engagement in the learning process and their motivation to learn English.
3. To assess changes in the academic performance of students taught using communicative methodologies compared to those using traditional methods.

4. To explore the impact of the communicative approach on the development of speaking and listening skills in students with different levels of preparation.

To enhance the clarity and accessibility of the article, an explicit description of its structure is provided, helping readers anticipate the organization of the document. The introduction outlines the relevance of the communicative approach in teaching English and its adaptation challenges within the Ukrainian higher education context. The next section reviews the methodology used, including details of the research design, participants, tools, and procedures. Following this, the results section presents findings on the impact of the communicative approach on students' engagement, motivation, and language competencies. The discussion section analyzes these findings in relation to existing studies, emphasizing their significance and potential applications in the Ukrainian educational landscape. The article concludes by summarizing the main insights, highlighting limitations, and proposing directions for future research to advance the integration of communicative methodologies in higher education.

Literature review

The literature review of this study examines the landscape of the communicative approach adaptation in teaching English in higher education, with particular emphasis on the Ukrainian context. Through an analysis of recent research (2019-2023), four key dimensions are explored: the impact of the communicative approach on the development of language skills, the integration of educational technologies in teaching English, innovations in multimodal pedagogies, and emerging trends in post-pandemic teaching.

Impact of the communicative approach on language skills

Dos Santos (2020) highlights the effectiveness of active participation in communicative tasks, demonstrating significant improvements in students' oral proficiency. Similarly, Toro, Camacho-Minuche, Pinza-Tapia & Paredes (2019) emphasize the positive influence of the communicative approach on speaking skills. However, both studies lack robust longitudinal data to assess the sustainability of these improvements over time.

Integration of technology in communicative teaching

Studies such as those by Rinekso & Muslim (2020) and Syakur (2020) illustrate how online platforms like Google Classroom and synchronous discussions supported English learning during the pandemic. These studies point to increased accessibility and engagement but also reveal technical challenges and unequal participation, which limited effectiveness. The findings underscore the need for hybrid approaches that leverage the strengths of both online and face-to-face learning (Tratnik et al., 2019).

Critical thinking and multimodal pedagogies

Chang (2019) and Laadem & Mallahi (2019) explore the integration of multimodal pedagogies and translanguaging practices in English teaching. Both studies demonstrate increased student motivation and critical thinking development. However, the practical application of these methods remains constrained by resource shortages and the varying skill levels of students, calling for greater contextual adaptation.

Post-pandemic trends in English teaching

Emerging trends in English teaching reflect a shift toward flexible, technology-mediated approaches. Rinekso & Muslim (2020) document how the pandemic catalyzed innovations in synchronous online teaching. However, issues such as digital fatigue and disparities in technological infrastructure highlight the necessity of balanced methodologies that address both technological and pedagogical needs. This shift is

particularly relevant in the Ukrainian context, where online learning platforms are increasingly integrated into higher education.

Critical analysis of methodological limitations and contradictory findings

Despite the consensus on the communicative approach's benefits, the cited studies often lack rigorous experimental designs and fail to account for confounding variables such as students' individual characteristics and institutional disparities. For instance, while Dos Santos (2020) and Toro et al. (2019) report similar findings on oral proficiency improvement, their reliance on short-term interventions limits the generalizability of results. Furthermore, Chang (2019) and Laadem & Mallahi (2019) present promising outcomes from innovative methods but do not adequately address the scalability of these approaches in resource-constrained environments.

Contradictions arise regarding the effectiveness of online versus traditional teaching formats. While Tratnik et al. (2019) found comparable satisfaction levels among students in both settings, other studies highlight challenges in maintaining interaction and engagement in fully online environments (Syakur, 2020). These discrepancies suggest the need for context-specific research to identify optimal blends of online and face-to-face instruction.

Connections between international literature and the local context

While international studies provide valuable insights into the communicative approach, their application in Ukraine requires careful consideration of local educational challenges. For example, the resource constraints and regional disparities highlighted by Laadem & Mallahi (2019) resonate with the Ukrainian higher education context, where rural institutions often struggle to implement innovative methods. Similarly, the findings of Rinekso & Muslim (2020) on the uneven participation in online learning underscore the importance of tailored solutions for Ukraine's diverse student populations.

By integrating these global perspectives with a focus on Ukraine's specific needs, this study aims to bridge the gap between international best practices and local implementation. Expanding research on post-pandemic teaching trends, particularly hybrid models, can offer practical solutions for enhancing English teaching in Ukrainian higher education.

Methods and materials

Research procedure

The study was conducted during the 2023-2024 academic year by researchers from Sumy National Agrarian University (Foreign Languages Department, Faculty of Biology and Technology). The research utilized an experimental design with a combined approach that integrates both quantitative and qualitative methods. The study consisted of four stages. The first stage involved the preparation and development of educational materials based on the communicative approach, as well as the development of tools for data collection. The second stage included conducting pilot testing to assess the effectiveness of the materials and methods in the control groups. The third stage was the main phase of experimental learning, where students applied new methods in real educational settings. In the final stage, data analysis was conducted, which included evaluating the learning outcomes and comparing the effectiveness of the communicative approach with traditional methods.

Selection

A sample of 180 students from Sumy National Agrarian University, studying at the Faculty of Biology and Technology in the foreign languages department, was formed for the study. All participants were first- and second-year students. The sample included students aged 18 to 22 who specialize in biology and technology. To collect data, surveys and tests were conducted with the students, which were voluntary and

did not conflict with their interests. The survey was developed by the authors of this study in 2024. Testing was conducted using online platforms such as Google Forms and Zoom. This provided convenient access to tests and surveys, encouraging active student participation. The sample was formed using a random method, ensuring representativeness and reducing the likelihood of systematic errors. The students were randomly divided into two groups: the experimental group (EG) used the communicative approach in their studies, while the control group (CG) continued learning through traditional methods.

Research Methods

The following methods were used in the study:

1. *Questionnaire*: A survey was conducted to collect primary data on the students' communicative skills levels before and after the implementation of the communicative approach.
2. *Testing*: Standardized tests were used to assess the students' language skills, including tasks to check grammatical knowledge, lexical skills, and both oral and written communication.
3. *Observation*: Systematic observation of students' activity during lessons was conducted throughout the educational process.
4. *Interviews*: Semi-structured interviews were conducted to gather qualitative data on students' experiences and impressions of the communicative approach.

Statistical analysis

1. *Levene's Test*

Levene's test was used to check for homogeneity of variances between the groups:

$$W = \frac{(N-k)}{(k-1)} \times \frac{\sum_{i=1}^{k} N_i \, (Z_{i.}-Z_{..})^{\,2}}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} (Z_{ij}-Z_{i.})^{\,2}},$$

N *– total number of observations*

k *– number of groups*

N_i *– number of observations in the i-th group*

Z_{ij} *– transformed distance for the j-th element in the i-th group*

$Z_{i.}$ *– mean value of Z_ij in the i-th group*

$Z_{..}$ *– overall mean value of Z_ij for all groups*.

2. *The Mann-Whitney test*

The Mann-Whitney test was used to compare medians between two independent groups, especially when the data does not follow a normal distribution:

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1, U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

$n_1 n_2$ – sample sizes

R_1 – sum of ranks for the first sample
R_2 – sum of ranks for the second sample.

3. *Other Methods*

- *t-test for independent samples:* used to compare mean values between two groups when the data follows a normal distribution and has equal variances;
- *Analysis of variance (ANOVA):* used to compare mean values between three or more groups, allowing to determine whether there are statistically significant differences between groups;
- *Correlation analysis:* used to assess the strength and direction of the relationship between variables, allowing to determine how changes in one variable might be related to changes in another.

Results

The analysis of the study's findings focuses on assessing the effectiveness of the communicative approach in enhancing students' communicative competencies. By employing quantitative methods, including the Mann-Whitney test, the study evaluated changes in grammatical knowledge, lexical skills, and oral and written communication before and after the implementation of this approach. These findings highlight the transformative potential of communicative methodologies, shedding light on key areas of improvement and their implications for educational practices in higher education.

Table 1, which shows the results of the Mann-Whitney test, provides an understanding of changes in students' communicative competencies before and after the introduction of the communicative approach, evaluating various aspects of language skills such as grammatical knowledge, lexical skills, and oral and written communication. The analysis of each category reveals important trends and shows the significant impact of using communicative methods in the educational process.

Table 1.
Comparison of students' communicative competence levels before and after the implementation of the communicative approach

Category	Group	Median Before (Me)	Median After (Me)	Rank Before (R)	Rank After (R)	U (Mann-Whitney Statistic)	p-value
Grammatical Knowledge	Experimental	65	81	22.4	36.7	432.0	0.001
	Control	67	70	24.6	29.3		
Lexical Skills	Experimental	62	79	21.9	35.5	460.5	0.002
	Control	63	68	23.1	28.9		
Oral Skills	Experimental	60	82	22.1	37.1	410.5	0.001
	Control	61	65	23.9	29.0		
Writing Skills	Experimental	58	80	21.5	36.3	442.0	0.001
	Control	60	66	23.6	28.7		

Source: developed by the author based on collected data from the participants of the experiment

1. Grammatical knowledge.

Before the implementation of the communicative approach, the median score for the experimental group was 65%, while the control group showed a slightly higher median of 67%. However, after the implementation of the methodology, the experimental group showed a significant improvement, reaching 81%, while the control group only improved to 70%. This indicates that the communicative approach significantly enhanced grammatical knowledge, whereas traditional methods used in the control group produced a less pronounced result. The average rank results also support these conclusions: the experimental group saw an increase in rank from 22.4 to 36.7, while the control group shifted from 24.6 to 29.3. The Mann-Whitney U-test value (432.0) and the low p-value (0.001) indicate statistically significant differences between the groups, confirming the effectiveness of the communicative approach in improving grammatical knowledge.

2. Lexical skills.

The results of the lexical skills test present a similar picture. The median score for the experimental group before the introduction of the communicative approach was 62%, and after the implementation, it increased to 79%. The control group showed less improvement, from 63% to 68%. This finding highlights that the communicative approach not only improves grammar but also leads to a deeper acquisition of lexical structures. The changes in rank results confirm this conclusion. In the experimental group, ranks rose from 21.9 to 35.5, reflecting significant improvement. In the control group, ranks also increased, but less markedly: from 23.1 to 28.9. The Mann-Whitney U-test value (460.5) and p-value (0.002) confirm that these changes are statistically significant.

3. Oral communication.

The evaluation of oral communication skills also shows positive changes after the introduction of the communicative approach. The median score for the experimental group before the introduction was 60%, while after it increased to 82%, demonstrating a sharp improvement. In the control group, changes were less pronounced, rising from 61% to 65%. This emphasizes the importance of communicative methods in developing oral communication skills. The rank results also show a significant increase in the experimental group (from 22.1 to 37.1), while in the control group, ranks barely changed (from 23.9 to 29.0). The Mann-Whitney U-test value (410.5) and p-value (0.001) also indicate statistically significant differences, confirming the effectiveness of the methods in developing oral communication.

4. Written communication.

The assessment results for written communication demonstrate a similar trend. Before the communicative approach, the median score in the experimental group was 58%, while after implementation, it reached 80%. In the control group, the median also increased, but only slightly, from 60% to 66%. This points to the significant impact of the communicative approach on the development of written skills. The rank results also confirm this growth: in the experimental group, ranks increased from 21.5 to 36.3, while in the control group, they remained almost unchanged (from 23.6 to 28.7). The Mann-Whitney U-test value (442.0) and p-value (0.001) indicate the presence of statistically significant changes in written communication results.

Before the study, the average student activity levels were relatively low in both groups. In the control group, the average activity level was 3.4 points (on a 5-point scale), while in the experimental group, it was 3.5 points. This indicates that both groups had a similar initial level of participation in the educational process. After the introduction of communicative methods, student activity levels in the experimental group significantly increased. The average activity level rose to 4.6 points, a substantial improvement compared to the initial level. In the control group, where traditional teaching methods were used, a slight increase in activity was also observed—to 3.7 points—but this level was much lower than in the experimental group.

The motivation to study English also showed similar changes. Before the introduction of communicative methods, the average motivation score in the experimental group was 3.3 points, while in the control group, it was 3.2 points. After applying the communicative approach, the average student motivation in the experimental group increased to 4.5 points, while in the control group, this indicator rose only to 3.5 points. The Mann-Whitney U-test results showed statistically significant differences between the groups after the introduction of the communicative approach. The U-test value for student activity levels was 380.0 ($p < 0.01$), indicating a significant increase in activity in the experimental group. The motivation test also showed statistically significant results, with a U-test value of 395.5 ($p < 0.01$), confirming the impact of the communicative approach on improving motivation to learn English.

Before the experiment, the average academic performance of students in both groups was comparatively equal (Figure 1). In the experimental group, the average score was 76.8 (on a 100-point scale), while in

the control group, it was 77.2. This indicates a similar level of knowledge and skills in both groups before the introduction of the communicative methodology.

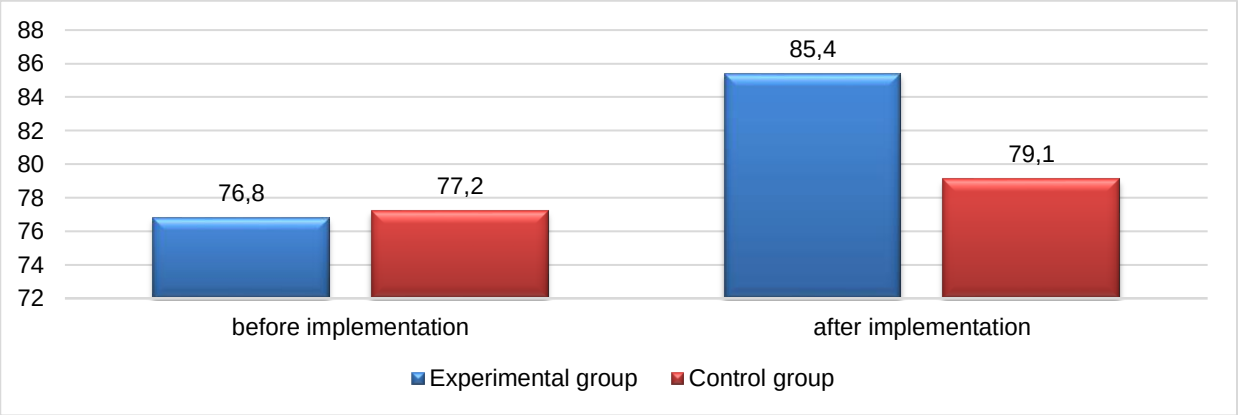

Figure 1. The impact of the communicative methodology on academic performance.
Source: developed by the author based on collected data from the experiment participants.

After the conclusion of the study period, during which the communicative methodologies were applied in the experimental group, there was a significant improvement in academic performance. The average score in the experimental group increased to 85.4, indicating a notable enhancement in outcomes. In the control group, there was also a slight increase in the average score to 79.1; however, this improvement was much smaller compared to the students in the experimental group. Levene's test value was 4.78 ($p < 0.05$), indicating unequal variances between the two groups.

The results of the study on the impact of the communicative approach on the development of oral communication and listening skills in students of different proficiency levels showed significant changes in their communication competencies (Figure 2).

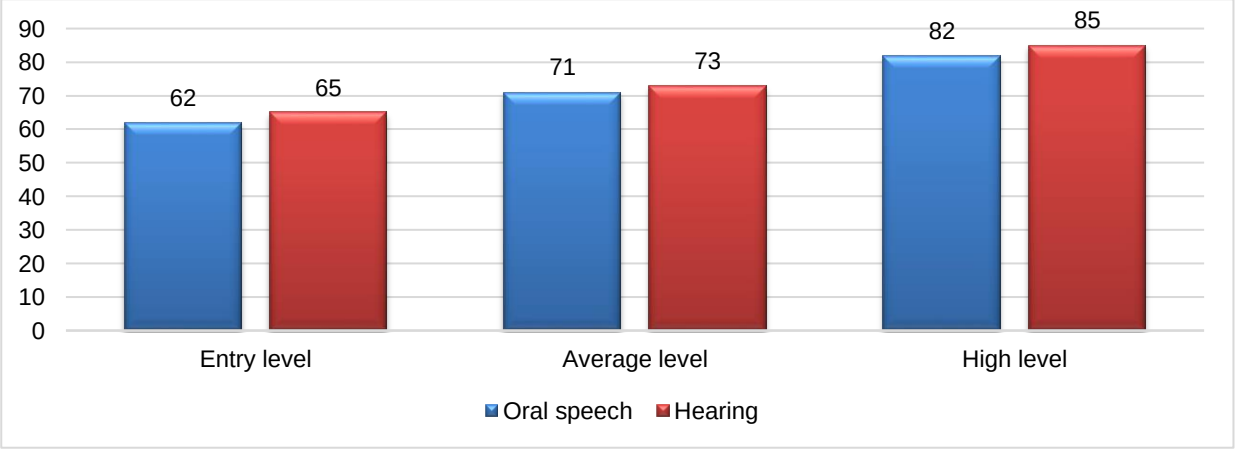

Figure 2. Level of oral and listening skills before the experiment.
Source: developed by the author based on collected data from the experiment participants.

Before the start of the experiment, students with a beginner proficiency level demonstrated lower results in oral communication (average score – 62) and listening (average score – 65). This was in comparison to students at the intermediate level (oral communication – 71, listening – 73) and the advanced level (oral communication – 82, listening – 85). These indicators confirmed that students at different stages of language learning had varying initial skill levels. After the implementation of the communicative approach, improvements were observed in all groups (Figure 3).

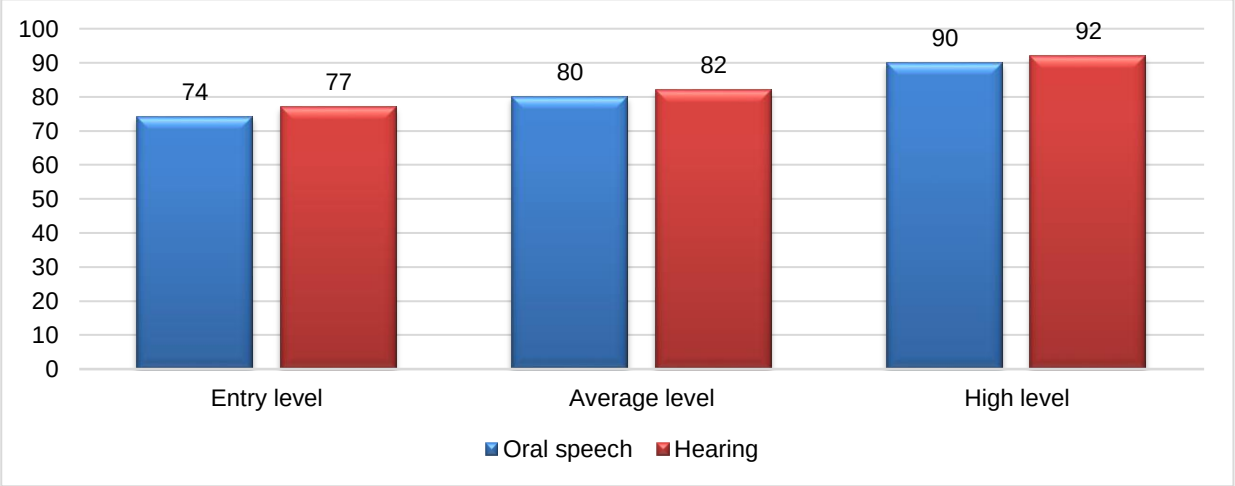

Figure 3. Level of oral and listening skills after the experiment.
Source: developed by the author based on collected data from the experiment participants.

Students at the beginner level achieved noticeable progress: the average score for oral communication increased to 74, and for listening, it rose to 77. The intermediate group also showed growth: oral communication reached 80, and listening improved to 82. Students at the advanced level demonstrated even better results: their oral communication skills increased to 90, and their listening skills reached 92 points.

The ANOVA test indicated statistically significant differences among the groups based on their proficiency levels. The F value for oral communication was 8.23 ($p < 0.001$), indicating the significance of the communicative approach's impact on oral skills. For listening skills, the F value was 7.89 ($p < 0.001$), which also confirms the significance of the changes among the groups. This means that the students' proficiency level significantly influences their progress in developing communicative competencies when using the communicative approach.

Correlation analysis revealed a strong positive correlation between oral communication and listening skills ($r = 0.78$, $p < 0.01$), indicating that students who excel in one of these skills typically demonstrate improvements in the other as well. This suggests that the communicative approach fosters the simultaneous development of both skills, and these skills are closely interconnected in the learning process.

Discussion

During the study, significant improvements in the level of communicative competencies among students were identified after implementing a communicative approach to teaching English. In particular, students in the experimental group demonstrated better results in tests assessing grammatical and lexical skills, as well as oral and written communication. Additionally, their motivation to learn, and engagement in class noticeably increased. This supports the idea that interactive methods and a focus on practical language use enhance student interest and their learning progress.

A significant contribution to the development of English teaching methodologies has been made by researchers such as Singh, Singh, Ja'afar, Tek, Kaur, Moastafa & Yunus (2020), who investigated teaching strategies aimed at fostering higher-order thinking skills during the study of English literature. Their findings indicated that integrating such strategies enhances students' analytical skills and promotes a deeper understanding of texts. Macaro, Akincioglu & Han (2020) examined teachers' views on professional development and certification in English teaching at higher education institutions. They emphasized the importance of continuous professional improvement and enhancing teachers' competencies to ensure a

quality learning process. Patak, Wirawan, Abduh, Hidayat, Iskandar & Dirawan (2021) analyzed Indonesian university teachers' perspectives on plagiarism in teaching English as a foreign language. They found that teachers employed various approaches to prevent plagiarism, including the use of technological tools and educational initiatives. Ayu & Pratiwi (2021) studied the implementation of online learning during the pandemic in English teaching. They concluded that remote learning became a necessity and encouraged teachers to seek innovative approaches to maintain student engagement. De Jager, Rwodzi & Mpofu (2020) explored the innovative use of social media for teaching English as a second language. Their results indicate that social media serves as an effective tool for developing students' language skills in an informal learning environment.

The findings of this research align with the conclusions drawn by Hamad, Metwally & Alfaruque (2019), who highlight that the communicative approach enhances students' oral and written skills. Their study demonstrated that students taught using this methodology exhibited higher language competence and adapted more easily to new communication situations. Research by Salem (2019) also found a positive impact of the communicative approach on the development of oral skills. Our results corroborate their findings, indicating that the communicative approach aids students in expressing their thoughts in English more easily and confidently.

In the work of Crisianita & Mandasari (2022), it was noted that communicative methodologies not only allow students to develop language skills but also facilitate better integration of knowledge across other disciplines. Our study also revealed that students in the experimental group found it easier to apply their knowledge in different contexts, underscoring the versatility of the communicative approach. Similar conclusions were drawn in the research conducted by Chen, Chen & Yang (2019), who found that students learning English through a communicative methodology were more satisfied with the learning process and exhibited a higher level of motivation. Our study confirmed these results, showing an increase in the motivation and engagement of students in the experimental group during classes.

In the study by Saed, Haider, Al-Salman & Hussein (2021), it was found that the communicative approach positively affects students' awareness of the practical significance of language in real life. A similar effect was observed in our research, where students in the experimental group displayed a higher capacity for practical language application, indicating an increase in their motivation and interest in learning English. The practical application of the obtained results involves integrating the communicative approach into English language curricula at higher education institutions. Implementing the research findings will help create more effective teaching materials, improve language skill assessments, and develop specialized courses for educators (Zhylin et al., 2023).

Limitations of the Study

The limitations of the study include a limited sample size, which consisted only of students from one higher educational institution, potentially affecting the generalizability of the results to other contexts or regions. Furthermore, the study focused solely on the impact of the communicative approach on English language learning.

Recommendations

Based on the obtained results, it is recommended to implement the communicative approach in English language curricula at universities. It is also suggested to improve the methods of assessing language skills, particularly by introducing interactive testing and tasks that reflect real-life language use.

Conclusions

Based on the conducted research, it can be asserted that the implementation of the communicative approach in English language teaching significantly improves students' communicative competencies. The analysis of test results showed that students who were taught using the communicative methodology

demonstrated significant improvements in grammatical knowledge and lexical skills. The communicative approach positively affects students' motivation and engagement in the learning process, reflected in increased interest and independence in using English. The results also indicated that students who underwent training using the communicative approach achieved significant improvements in academic performance. Future research may focus on studying the long-term effects of the communicative approach, particularly its impact on students' language skills after completing the course.

Practical implications

The results of this study highlight several practical applications for educators and policymakers. First, institutions should prioritize the integration of communicative teaching methodologies into English language programs, emphasizing interactive activities such as role-playing, group discussions, and project-based learning. Second, training programs for instructors should focus on equipping them with the skills needed to effectively implement communicative techniques, including managing diverse student needs and fostering a motivational learning environment. Third, adopting hybrid teaching models that blend face-to-face and online learning can enhance flexibility and accessibility while maintaining the interactive elements essential to the communicative approach.

Recommendations for future research

Future studies should investigate the long-term effects of the communicative approach, particularly its impact on students' language retention and real-world communication skills after completing their courses. Additionally, research could explore the effectiveness of this methodology in different educational contexts, such as rural versus urban institutions, to address regional disparities in language education. Finally, examining the integration of emerging technologies, such as AI-driven language learning tools, with communicative teaching practices could provide innovative solutions for enhancing language proficiency in diverse learning environments.

Bibliographic references

Ali, S. S. (2019). Problem based learning: A student-centered approach. *English Language Teaching*, *12*(5), 73–78. https://doi.org/10.5539/elt.v12n5p73

Ayu, M., & Pratiwi, Z. F. (2021). The implementation of online learning in English language teaching during pandemic: The teachers voice. *Journal of Research on Language Education*, *2*(2), 93–99. Retrieved from: https://ejurnal.teknokrat.ac.id/index.php/JoRLE/article/view/1316/619

Castro, L., & Villafuerte, J. (2019). Strengthening English language teaching in rural schools through the role-playing: Teachers' motivations. *International Journal of Educational Methodology*, *5*(2), 289–303. https://doi.org/10.12973/ijem.5.2.289

Chang, S. Y. (2019). Beyond the English box: Constructing and communicating knowledge through translingual practices in the higher education classroom. *English Teaching & Learning*, *43*(1), 23–40. https://doi.org/10.1007/s42321-018-0014-4

Chen, C. M., Chen, L. C., & Yang, S. M. (2019). An English vocabulary learning app with self-regulated learning mechanism to improve learning performance and motivation. *Computer Assisted Language Learning*, *32*(3), 237–260. https://doi.org/10.1080/09588221.2018.1485708

Chen, H. L., & Wu, C. T. (2023). A digital role-playing game for learning: Effects on critical thinking and motivation. *Interactive Learning Environments*, *31*(5), 3018–3030. https://doi.org/10.1080/10494820.2021.1916765

Crisianita, S., & Mandasari, B. (2022). The use of small-group discussion to imrpove students'speaking skill. *Journal of English Language Teaching and Learning*, *3*(1), 61–66.

De Jager, L., Rwodzi, C., & Mpofu, N. (2020). The innovative use of social media for teaching English as a second language. *TD: The Journal for Transdisciplinary Research in Southern Africa*, *16*(1), 1–7. Retrieved from: https://hdl.handle.net/10520/EJC-1d2c55516c

Dos Santos, L. M. (2020). The discussion of communicative language teaching approach in language classrooms. *Journal of Education and e-Learning Research*, *7*(2), 104–109. https://doi.org/10.20448/journal.509.2020.72.104.109

Fandiño, F. G. E., Muñoz, L. D., & Velandia, A. J. S. (2019). Motivation and e-learning English as a foreign language: A qualitative study. *Heliyon*, *5*(9), e02394. https://doi.org/10.1016/j.heliyon.2019.e02394

Frumkina, A., Diachenko, M., Polyezhayev, Y., Savina, N., & Hadi, F. (2020). Readiness of future teachers for integrated teaching of educational subjects in foreign language. *Revista Práxis Educacional, 16*(38), 502–514. Retrieved from: https://periodicos2.uesb.br/index.php/praxis/article/view/6023

Hamad, M. M., Metwally, A. A., & Alfaruque, S. Y. (2019). The impact of using YouTubes and audio tracks imitation YATI on improving speaking skills of EFL learners. *English Language Teaching*, *12*(6), 191–198. https://doi.org/10.5539/elt.v12n6p191

Konotop, O., Bykonia, O., Bondar, O., Shevchenko, Y., & Kasianchuk, N. (2021). Practice of using GoToMeeting/Zoom in the study of foreign languages. *Journal for Educators, Teachers and Trainers*, *12*(3), 176–185. Retrieved from: https://jett.labosfor.com/index.php/jett/article/view/557

Laadem, M., & Mallahi, H. (2019). Multimodal pedagogies in teaching English for specific purposes in higher education: Perceptions, challenges and strategies. *International Journal on Studies in Education, 1*(1), 33–38. Retrieved from: https://acortar.link/Kd78G9

Macaro, E., Akincioglu, M., & Han, S. (2020). English medium instruction in higher education: Teacher perspectives on professional development and certification. *International journal of applied linguistics*, *30*(1), 144–157. https://doi.org/10.1111/ijal.12272

Namaziandost, E., Neisi, L., Kheryadi, & Nasri, M. (2019). Enhancing oral proficiency through cooperative learning among intermediate EFL learners: English learning motivation in focus. *Cogent Education*, *6*(1), 1683933. https://doi.org/10.1080/2331186X.2019.1683933

Patak, A. A., Wirawan, H., Abduh, A., Hidayat, R., Iskandar, I., & Dirawan, G. D. (2021). Teaching English as a foreign language in Indonesia: University lecturers' views on plagiarism. *Journal of Academic Ethics*, *19*, 571–587. https://doi.org/10.1007/s10805-020-09385-y

Rinekso, A. B., & Muslim, A. B. (2020). Synchronous online discussion: teaching English in higher education amidst the covid-19 pandemic. *JEES (Journal of English Educators Society), 5*(2), 155–162. https://doi.org/10.21070/jees.v5i2.646

Robert, R., & Meenakshi, S. (2022). Rereading oral communication skills in English language acquisition: The unspoken spoken English. *Theory and Practice in Language Studies*, *12*(11), 2429–2435. https://doi.org/10.17507/tpls.1211.25

Saed, H. A., Haider, A. S., Al-Salman, S., & Hussein, R. F. (2021). The use of YouTube in developing the speaking skills of Jordanian EFL university students. *Heliyon*, *7*(7), e07543. https://doi.org/10.1016/j.heliyon.2021.e07543

Salem, A. A. (2019). A sage on a stage, to express and impress: TED talks for improving oral presentation skills, vocabulary retention and its impact on reducing speaking anxiety in ESP settings. *English Language Teaching*, *12*(6), 146–160. https://doi.org/10.5539/elt.v12n6p146

Seraj, P. M. I., & Hadina, H. (2021). A systematic overview of issues for developing EFL learners' oral English communication skills. *Journal of Language and Education*, *7*(1), 229–240.

Singh, C. K. S., Singh, T. S. M., Ja'afar, H., Tek, O. E., Kaur, H., Moastafa, N. A., & Yunus, M. (2020). Teaching strategies to develop higher-order thinking skills in English literature. *International Journal of Innovation, Creativity and Change*, *11*(80), 211–231. Retrieved from: https://www.ijicc.net/images/vol11iss8/11816_Singh_2020_E_R.pdf

Slipetska, V., Bortun, K., Zhylin, M., Horlachova, V., & Kosharnyi, K. (2023). Structure and semantics of verbal means of expressing states of emotional tension in English publicistic texts. *Amazonia Investiga*, *12*(67), 212–222. https://doi.org/10.34069/AI/2023.67.07.19

Syakur, A. (2020). The effectiveness of english learning media through google classroom in Higher Education. *Britain International of Linguistics Arts and Education (BIoLAE) Journal*, *2*(1), 475–483. https://doi.org/10.33258/biolae.v2i1.218

Thu, N. T. H. (2020). Communication skills and reflection practice in smart english teaching and learning environment: A case study. *International Journal of Emerging Technologies in Learning (iJET), 15*(17), 221–237. https://doi.org/10.3991/ijet.v15i17.15235%0d

Toro, V., Camacho-Minuche, G., Pinza-Tapia, E., & Paredes, F. (2019). The use of the communicative language teaching approach to improve students' oral skills. *English Language Teaching*, *12*(1), 110–118. https://doi.org/10.5539/elt.v12n1p110

Tratnik, A., Urh, M., & Jereb, E. (2019). Student satisfaction with an online and a face-to-face Business English course in a higher education context. *Innovations in education and teaching international, 56*(1), 36–45. https://doi.org/10.1080/14703297.2017.1374875

Van Atteveldt, W., Van der Velden, M. A., & Boukes, M. (2021). The validity of sentiment analysis: Comparing manual annotation, crowd-coding, dictionary approaches, and machine learning algorithms. *Communication Methods and Measures*, *15*(2), 121–140. https://doi.org/10.1080/19312458.2020.1869198

Zhylin, M., Mendelo, V., Cherusheva, G., Romanova, I., & Borysenko, K. (2023). Analysis of the role of emotional intelligence in the formation of identity in different European cultures. *Amazonia Investiga*, *12*(62), 319–326. https://doi.org/10.34069/AI/2023.62.02.32

Check for updates

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.13

Cómo citar:
Tytska, Y. (2024). International scientific cooperation and domestic organizational and program mechanisms. *Revista Eduweb*, *18*(4), 191-204. https://doi.org/10.46502/issn.1856-7576/2024.18.04.13

International scientific cooperation and domestic organizational and program mechanisms

Cooperación científica internacional y mecanismos organizativos y programáticos nacionales

Yana Tytska

https://orcid.org/0000-0001-5777-8225
yana1maslova@gmail.com
Ph.D. Associate Professor, Dean of the Faculty of Law and Economics of the International Humanitarian University (Odesa, Ukraine).

Recibido: 24/10/27
Aceptado: 25/12/10

Abstract

This article investigates the integration of international legal standards for scientific cooperation within Ukraine's legal framework, addressing the absence of a consistent doctrinal foundation. It emphasizes the need to harmonize Ukraine's regulatory system with contemporary international and supranational standards, particularly through international treaty mechanisms. While European and American scholars have extensively studied supranational scientific collaboration standards, their practical application within Ukraine's legal and organizational systems remains underexplored. This research fills the gap by analyzing models for implementing a European treaty model, aiming to influence both Ukrainian legal norms and related organizational acts. The study employs a multidisciplinary methodology, including predictive, programmatic, hermeneutic, formal-legal, systematic, and comparative methods, to critically assess Ukrainian legislation and its organizational acts. It identifies significant contradictions and challenges in aligning universal and European scientific standards with national legal practices. Key findings reveal inconsistencies in regulating international agreements, leading to fragmented scientific priorities and limited effectiveness in collaboration. The Ministry of Education and Science, as the main regulatory body, faces criticism for undermining academic freedom. These deficiencies hinder Ukraine's integration into the global scientific community, necessitating urgent reforms to synchronize regulatory frameworks, ensure academic freedom, and enhance the effectiveness of international scientific cooperation.

Keywords: international scientific programs, international scientific projects, science, scientific research, scientific and technical cooperation.

Resumen

Este artículo examina el panorama cambiante de la cooperación jurídica internacional en materia de investigación científica en el derecho ucraniano, destacando la ausencia de un marco estable en la doctrina jurídica. Subraya la importancia de armonizar el sistema regulatorio de Ucrania con el derecho internacional contemporáneo y las normas supranacionales, en particular mediante la cooperación en virtud de tratados internacionales.
A pesar de la literatura existente de académicos europeos y estadounidenses que abordan las normas supranacionales para la colaboración científica, la integración de estos principios en los marcos jurídicos y organizativos de Ucrania sigue sin explorarse. Esta brecha subraya la necesidad de un análisis exhaustivo de los modelos y formatos que podrían implementar de manera efectiva un modelo de tratado europeo para la

investigación científica, lo que repercutiría tanto en el contenido de las normas jurídicas ucranianas como en los actos organizativos asociados.
El estudio se centra en la integración de la cooperación científica supranacional en las regulaciones nacionales, con el objetivo de delinear las especificidades de la implementación de las normas jurídicas internacionales en el marco jurídico interno de Ucrania. Investiga sistemáticamente los desafíos y contradicciones que surgen al alinear las normas científicas universales y europeas con las prácticas legislativas nacionales. Utilizando una variedad de métodos analíticos –incluidos los enfoques predictivos, programáticos, hermenéuticos, formal-legales, sistemáticos y comparativos– la investigación critica los actos organizativos actuales en la legislación ucraniana. Revela inconsistencias significativas en el tratamiento de los acuerdos internacionales y sus implicaciones para las prioridades y la eficacia científicas nacionales.
Los hallazgos indican que el Ministerio de Educación y Ciencia actúa como el principal organismo regulador, pero su supervisión plantea preocupaciones sobre la libertad académica. Además, la falta de sincronización en la regulación de las prioridades científicas y los criterios de eficacia limita el potencial de libertad académica y socava el marco regulatorio necesario para una colaboración científica internacional eficaz. Esta situación presenta un desafío considerable para la integración de Ucrania en la comunidad científica mundial, lo que requiere una reforma urgente.

Palabras clave: programas científicos internacionales, proyectos científicos internacionales, ciencia, investigación científica, cooperación científica y técnica.

Introduction

International legal cooperation concerning scientific activity, technical collaboration, and research remains inadequately defined within Ukrainian legal doctrine. The absence of a stable format and systematic framework significantly hampers efforts to adopt an evolutionary and coherent approach to harmonizing Ukraine's regulatory system with contemporary international law. This issue is particularly pressing given Ukraine's commitments under international treaties and the increasing importance of integrating supranational requirements into domestic governance.

For instance, despite Ukraine's ratification of several international agreements such as the Horizon 2020 and Horizon Europe frameworks, the lack of a cohesive implementation strategy has led to inefficiencies in accessing funding and participating in collaborative research projects. In 2022, Ukraine secured only a fraction of available Horizon Europe grants compared to its European counterparts, underscoring the practical implications of its fragmented regulatory approach.

While significant research exists on supranational standards for scientific and technical collaboration—particularly by European and American scholars—these critical issues have yet to receive thorough examination in the context of Ukraine's regulatory framework. This gap is evident in the inconsistent incorporation of international standards into domestic organizational and programmatic mechanisms, as highlighted by frequent amendments and delays in the adoption of laws regulating scientific collaboration.

In light of these challenges, a systematic analysis of relevant models and formats for implementing a universal and European treaty framework is urgently needed. For example, the European Union's structured integration of the European Research Area provides a proven model that could guide Ukraine in aligning its national policies with supranational standards. Such alignment is essential not only for enhancing research practices but also for modernizing Ukrainian legislation and associated organizational acts.

This article seeks to explore the nuances of supranational scientific cooperation as reflected in Ukraine's legal, organizational, and programmatic regulation of scientific research. Specifically, it aims to elucidate the characteristics of implementing international legal standards within the domestic legal model, examining their evolution, systematic nature, and classification.

To achieve these objectives, the study systematically investigates the paradoxes and challenges Ukraine

has encountered in incorporating universal and European standards into national regulations. For instance, the contradiction between academic freedom and rigid ministerial oversight exemplifies the systemic obstacles hindering progress. Addressing these issues requires a multifaceted approach that incorporates innovative and well-grounded legal, organizational, and programmatic reforms.

The research focuses on the following tasks:

Identifying fundamental challenges Ukraine faces in implementing international standards of scientific cooperation within domestic regulations;
Determining the forms and priorities of integrating international scientific cooperation standards into national frameworks;
Examining the role of organizational and programmatic acts in aligning domestic legal models with global standards;
Outlining the features of managerial and programmatic support for implementing international scientific cooperation standards.

To provide a comprehensive analysis, the article is structured as follows:

Theoretical Framework and Literature Review: This section reviews existing scholarly work on supranational standards for scientific cooperation, highlighting gaps in the current understanding of their integration into national legal systems, particularly within Ukraine.

Methodology: Here, the study outlines the qualitative and exploratory methods employed, including forecasting, hermeneutic, formal-legal, systematic, and comparative analyses. It details the step-by-step application of these methods and the procedures implemented to ensure the rigor and quality of the research.

Results and Discussion: This section presents the key findings from the analysis, illustrating the practical impacts of Ukraine's fragmented regulatory framework with concrete examples and data. It discusses the implications of these results for Ukraine's integration into the global scientific community.

Conclusion: The final section summarizes the main findings, reflects on the study's limitations, and offers recommendations for policy reforms aimed at harmonizing Ukraine's legal frameworks with international scientific cooperation standards.

By addressing these tasks and following this structured approach, the study aims to provide actionable insights into aligning Ukraine's scientific research regulations with international best practices, ensuring effective integration into the global scientific community.

Theoretical Framework or Literature Review

Brief and fragmented considerations on the format and scope of implementing international standards of scientific work into national administrative and programmatic acts can be observed in individual documents from specialized institutions and other UN bodies (Tytska, & Babin, 2023; 2024) These can also be seen in the search for systemic models to counter widespread Russian aggression (Babin, Chvaliuk, & Plotnikov, 2021a; Babin, Plotnikov, & Prykhodko, 2023a; Babin, 2019; Babin, Chvaliuk, & Plotnikov, 2021b). At the same time, existing research works are rather limited in scope.

Among contemporary authors in the USA and the EU, D. Bridget, M. Horvat, N. Ruffin, J. Fickers, T. Flink, and W. Schreiterer have addressed these issues in their works (Bridget, 2012; Fikkers, & Horvat, 2014; Flink & Schreiterer, 2010; Rüffin, 2021; Rüffin, & Schreiterer, 2017). However, these studies do not specifically address the implementation of international standards of scientific cooperation into national programmatic legal sources.

However, these issues were also broadly mentioned in the reports provided by relevant expert institutions to authorized UN Special Rapporteurs, who made their own attempts to reflect these developments (Plotnikov, Chvaliuk, & Babin, 2022; Chvaliuk, Plotnikov, & Babin, 2023), particularly regarding the right to science and related managerial and programmatic activities for systemic scientific research within an international legal dimension. It is noteworthy that the UN Special Rapporteur, Professor Aikaterini Xanthaki, emphasized in her 2024 report, A/HRC/55/44 "The Right to Participate in Science," prepared for the UN Human Rights Council, that the right to participate in scientific activities in its various forms should be guaranteed to all.

The report called for the establishment of numerous, large-scale mechanisms for scientific and policy interaction and for the implementation of special measures to remove obstacles to the exercise of this right. At the same time, the UN Special Rapporteur added that during the formation of national governance mechanisms, scientific freedom should be guaranteed, and a human rights-based approach to science should be applied by all parties at all levels (Xanthaki, 2024). This stance by the UN representative should be considered in analyzing Ukraine’s implementation of international standards of scientific cooperation.

It is also important to note that within the context of report A/HRC/55/44, special attention should be given to its points on the democratization of science and its achievements, as well as on strengthening the protection of scientists, scientific actors, and science itself as a public good. This includes the protection of science from manipulation, misinformation, and disinformation (Xanthaki, 2024). Moreover, the UN Special Rapporteur noted that scientific institutions are underfunded, the space for civil society continues to narrow, and states should therefore develop citizen science programs that engage representatives of all population groups not only in data collection but in all aspects of scientific research, including methodology determination, developmental designs, result analysis, and reporting (Xanthaki, 2024).

In the context of systematically studying Ukraine's implementation of international standards of scientific cooperation, the directives of report A/HRC/55/44 remain highly relevant, particularly regarding the fact that information exchange among scientists and communities includes proposing research topics and presenting views on whether the overall research agenda is advancing in a way that meets the needs of the people (Xanthaki, 2024).

However, the proposals outlined by the UN Special Rapporteur have yet to achieve a cohesive and systematic realization, even within scientific inquiry itself. In the aforementioned report A/HRC/55/44, a key modern document on the international legal dimension of scientific activity, questions of implementing supranational research standards were practically not addressed, aside from a directive for states to establish and support diverse mechanisms of scientific and policy interaction. This should involve decision-making on scientific issues by all relevant stakeholders, including community representatives and researchers across all relevant disciplines, while duly respecting scientific diversity.

Meanwhile, the relevant issues of research implementation are increasingly reflected systematically in the works of contemporary authors who have sought to characterize various aspects of scientific activity in international law, including works by Achermann and Besson (2023), Besson (2023), and Shaver (2010; 2015). Additionally, doctrinal contributions to the right to science itself by Romano and Boggio (2024) are particularly significant.

Critical Examination of Limitations:

Fragmented Focus: Existing studies and reports often lack coherence, focusing on isolated aspects rather than providing a systematic framework for integrating international standards into national governance mechanisms. For instance, while Babin, Plotnikov, and Prykhodko (2023a) explore challenges arising from geopolitical contexts, they do not propose actionable solutions for programmatic legal adjustments.

Limited Applicability: Works by Bridget (2012) primarily focus on established systems within the EU or the USA, making their recommendations less applicable to transitional or developing legal systems like Ukraine's.

Insufficient Practical Examples: The lack of concrete case studies or examples from Ukraine or similar contexts leaves a gap in understanding the real-world applicability of these standards.

Broad Recommendations: The UN Special Rapporteur's report highlights important goals, such as fostering citizen science and protecting scientific endeavors from misinformation. However, it does not address the granular steps required for legal and institutional adaptation in specific jurisdictions.

Global Trends and Connection to the Article's Objectives:

Globally, there is an increasing emphasis on democratizing scientific collaboration and aligning research practices with human rights. The UN's directives advocate for fostering inclusive scientific dialogue and establishing mechanisms that involve diverse stakeholders in decision-making processes. For example, the idea of engaging citizens in all stages of research reflects a growing trend towards participatory science.

Despite these global advancements, Ukraine faces unique challenges in implementing these principles. The lack of a stable legal framework and the underfunding of scientific institutions, as highlighted in Xanthaki's report, exacerbate systemic inefficiencies. These gaps align directly with the article's objectives to:

Identify and address challenges in integrating international standards into Ukraine's programmatic and organizational frameworks.

Propose actionable strategies for harmonizing national practices with supranational norms.
Emphasize the importance of protecting academic freedom while fostering compliance with international cooperation standards.

By critically analyzing these studies and contextualizing their findings within Ukraine's legal environment, the article seeks to bridge the gap between broad theoretical recommendations and practical implementation strategies. This approach ensures that the proposed solutions are both globally informed and locally applicable.

Methodology

This study employed a qualitative and exploratory approach to analyze the integration of supranational scientific cooperation standards into Ukraine's regulatory and legal frameworks. The methodology was designed to address both doctrinal and practical dimensions, ensuring a comprehensive understanding of the challenges and opportunities in harmonizing national legislation with international models.

To predict future regulatory and organizational needs, forecasting and programmatic methods were applied. For example, legislative trends in Ukraine's science policy were analyzed to anticipate necessary adaptations for compliance with European treaties. Historical legislative patterns were triangulated with expert insights to enhance reliability.

Hermeneutic analysis was utilized to interpret legal texts, focusing on aligning international agreements with Ukraine's legal doctrine. Specific clauses of international treaties were examined to clarify their implications for Ukrainian organizational acts, with multiple interpretations compared to ensure objectivity. Complementing this, formal-legal analysis assessed the structure and language of Ukrainian laws, such as programmatic acts issued by the Ministry of Education and Science, to verify compliance with international standards.

To understand the interplay between legal and organizational frameworks, systematic analysis was employed. This mapped how individual norms influence broader regulatory systems. The analysis was peer-reviewed for systemic coherence. Additionally, comparative analysis evaluated Ukraine's frameworks against those of EU member states to identify best practices, selecting models relevant to Ukraine's legal landscape.

Analysis and synthesis techniques deconstructed complex regulations and synthesized actionable insights for reform. For instance, Ukraine's programmatic legal acts were broken down to identify gaps and propose integrated solutions. These findings were cross-verified with primary legal sources and secondary academic analyses.

The study ensured rigor through several procedures: (1) analyzing only verified departmental and programmatic texts; (2) dynamically monitoring regulatory updates to maintain relevance; (3) triangulating findings across methods; and (4) explicitly documenting the methodology and sources.

The research also addressed challenges, such as the uncertainty of unpublished or draft departmental acts, by conducting a systematic review that accommodated evolving regulatory landscapes. This structured, multi-method approach ensured robust conclusions and actionable recommendations for aligning Ukraine's legal frameworks with global scientific standards.

Results and Discussion

It is essential to immediately state that regarding the programmatic regulation of science, the Law of Ukraine "On State Target Programs" of March 18, 2004, No. 1621-IV (Law 1621-IV, 2004) does not provide for any format of interstate target programs, nor does it establish a procedure for foreign or international funding of state target programs. This law includes nationwide programs for scientific-technical development, as well as other scientific and scientific-technical programs.

At the same time, the Law of Ukraine "On Priority Areas of Science and Technology Development" of July 11, 2001, No. 2623-III (Law 2623-III, 2001) does not recognize Ukraine's international agreements as part of the legal foundation for forming and implementing priority areas of science and technology development. Amendments to this law, introduced after 2022, established new priority areas for the development of science and technology until the cessation or repeal of martial law in Ukraine. In this context, only fundamental scientific research on the most significant issues related to the development of scientific-technical, socio-economic, socio-political, and human potential for ensuring Ukraine's global competitiveness is included in the international dimension.

The relevant priorities are also reflected in the List of Priority Thematic Areas for Scientific Research and Scientific-Technical Developments, approved by Cabinet of Ministers Resolution 476 on April 30, 2024 (Resolution 476, 2024). This list adds dimensions such as "Ukraine's national interests in the context of the geopolitical issues of the modern globalized world and the establishment of a new international legal order" and "the development of the national legal system in the context of Ukraine's European and Euro-Atlantic integration." A similar approach to programming in the field of science is found in the Law of Ukraine "On Priority Directions of Innovation Activity in Ukraine" of September 8, 2011, No. 3715-VI (Law 3715-VI, 2011), which essentially does not establish grounds for international scientific cooperation.

Meanwhile, the issue of international programs is mentioned in the Law of Ukraine "On Scientific and Scientific-Technical Expertise" of February 10, 1995, No. 51/95-VR (Law 51/95-VR, 1995). This law mandates such expertise for "interstate scientific and scientific-technical programs implemented based on Ukraine's international agreements within its territory." However, this law lacks a specific international dimension regarding scientific expertise in terms of normative regulation sources or types of expertise. It simply notes that Ukraine's cooperation with other states in the area of scientific and scientific-technical

expertise is carried out under Ukraine's international agreements and that these agreements may establish "rules different from those provided by Ukrainian legislation on scientific and scientific-technical expertise."

Certain Ukrainian government acts still regulate or at least mention the supranational dimension of cooperation in the field of science. For example, the Procedure for Conducting State Attestation of Scientific Institutions and Higher Education Institutions regarding their scientific (scientific-technical) activities, approved by Cabinet of Ministers Resolution 540 on July 19, 2017 (Resolution 540, 2017), requires that information materials for such state attestation include details on international scientific-technical cooperation.

This information should include "the number of specialists who participated in international exhibitions and conferences, underwent internships, or conducted joint scientific research and developments abroad," as well as the number of international scientific-practical events conducted by the scientific institution, the number of foreign grants received, and "the number of projects conducted within EU framework programs for scientific research, development, and innovation, bilateral and multilateral agreements, and projects funded by international foundations and programs."

Following this assessment, all scientific institutions are categorized into one of four groups. Group A should include institutions "whose scientific research and developments are conducted at a world-class level and are of significant national and/or global importance, collaborating internationally and nationally" and "integrated into the global and/or European scientific and educational spaces." Group B should include institutions that "collaborate internationally and nationally and actively pursue integration into the global and/or European scientific and educational spaces," while Group C includes institutions that are "less known in the global scientific community" (Resolution 540, 2017).

Additionally, the Procedure for Forming the Topics of Scientific Research and Scientific-Technical (Experimental) Developments Funded by the State Budget, approved by Cabinet Order 13 on January 11, 2016 (Order 13, 2016), merely requires primary administrators to form these topics considering "global trends in science and technology in relevant fields" and "the market dynamics for science-intensive products worldwide." Similarly, the Standard Regulation on the Collective Use Center for Scientific Equipment, approved by Cabinet Resolution 703 on June 21, 2022 (Resolution 703, 2022), includes in the Center's tasks only "conducting joint research and developments by domestic and foreign scientific institutions" and "facilitating international scientific-technical cooperation."

It is worth noting that the Ukrainian government also aims to take certain organizational steps to facilitate international scientific cooperation, not only through developing norms within the relevant legislation but also based on agreements with the EU.

An example of such efforts is the Regulation on National Contact Points and the Coordination Center for the EU Framework Program for Research and Innovation "Horizon Europe" and the European Atomic Energy Community Research and Training Program (2021-2025), which complements the "Horizon Europe" program, approved by Resolution 214 on February 27, 2024 (Resolution 214, 2024). This document assigns the function of organizing "support and maintenance" for the "Horizon Europe" and "Euratom" programs to a specific employee of an organization with scientific subdivisions or a public scientific organization with legal entity status.

Similarly, the Coordination Center functions for the "Horizon Europe" and "Euratom" programs are assigned to an existing or specially created structural unit of an institution with scientific subdivisions, determined by an order of the Ministry of Education and Science of Ukraine (MESU) at the request of such a legal entity. For competitive selection, MESU establishes a selection commission for national contact points, and the list of national contact points for scientific, scientific-technical, and innovation activities is approved by an MESU order.

Lists of national contact points for other areas are approved by an order of the relevant ministry or department in agreement with MESU based on a written request. At the same time, the Regulation states that the functioning of national contact points must adhere to the standards and guidelines for national contact points approved by the European Commission, particularly in terms of "independence in performing the functions of a national contact point" (Resolution 214, 2024).

The Regulation also sets forth the tasks and functions of national contact points and the Coordination Center, along with general requirements for their activities and evaluation criteria. The funding for the activities of national contact points and the Coordination Center is to be covered by the respective legal entity's own income, with MESU only "ensuring the functioning of the National Portal for International Scientific and Technical Cooperation to host current information from national contact points."

Until 2024, similar mechanisms, albeit with more concise regulation, were established by the Regulation on the National Contact Point for the EU Framework Program for Research and Innovation "Horizon 2020," approved by MESU Order No. 1469 on December 8, 2016 (Order 1469, 2016). However, this order, unlike Resolution No. 214, allowed for the funding of national contact points to be sourced from international technical assistance and other non-prohibited sources.

In this context, it is also important to mention the Procedure for the Competition to Select Representatives and Experts for the Committees Responsible for Monitoring the Implementation of the EU Framework Program for Research and Innovation "Horizon 2020," approved by MESU Order No. 919 on June 23, 2017 (Order 919, 2017), and the Regulation on the Interdepartmental Coordination Council of MESU and the National Academy of Sciences of Ukraine for Cooperation between Ukraine and the European Organization for Nuclear Research, approved by MESU Order No. 1104/580 on September 14, 2016 (Order 1104/580, 2016), which outlined the responsibilities of the international cooperation and European integration department of the ministry (Order 1104/580, 2016).

The current Regulation on the Ministry of Education and Science of Ukraine (MESU), approved by Cabinet of Ministers Resolution No. 630 on October 16, 2014, in its current version, seeks to systematize, to some extent, the competencies of MESU in the realm of international scientific cooperation (Resolution 630, 2014). Notably, Article 2 of this Regulation does not mention international acts among the regulatory sources for MESU's activities, nor does it specify international or foreign grounds for establishing priority directions in the development of science and technology, state-targeted, or scientific-technical programs.

At the same time, this Regulation assigns MESU relevant powers in several areas. These include the integration of domestic science into the global scientific space, organizing cooperation between Ukraine and NATO in the field of science, coordinating international bilateral scientific-technical cooperation, working on the recognition of educational documents, scientific degrees, and academic titles issued in other countries through approval of appropriate procedures, ensuring Ukraine's cooperation with the European Community in education, science, innovation, and technology, and enabling Ukraine's participation in EU research and innovation programs.

The Regulation primarily mentions the conclusion of international agreements in the context of the minister's authority to conduct negotiations and sign international agreements on behalf of Ukraine, as well as represent MESU in relations with foreign and international bodies (Resolution 630, 2014). MESU essentially plays an integral role in any practical steps toward scientific cooperation, as evidenced by Government Resolution No. 1029 of September 6, 2024, on an experimental project for enhancing the autonomy of certain higher education institutions, specifically the National Aviation University, Zaporizhzhia National University, and Vasyl Stefanyk Precarpathian National University (Resolution 1029, 2024).

MESU is designated as the coordinator of this experimental project, and the resolution or the procedure approved by it do not mention any specific competencies of the universities regarding "autonomy development" in an international context. The supranational dimension of cooperation in this document

pertains to references to "receipts in the form of foreign grants, including from non-governmental sources," and the inclusion of foreigners on the "committee for the selection of supervisory board members of the project participants." The procedure specifies that the committee consists of three individuals appointed by MESU and three individuals appointed by MESU based on proposals from international organizations with which Ukraine cooperates in higher education under international agreements. However, the document does not clarify how this relates to ensuring "autonomy" for these universities.

A broader document in this field, approved at the MESU level, is the Procedure for the Registration of International Scientific-Technical Programs and Projects carried out within the framework of international scientific-technical cooperation by Ukrainian scientists, as well as grants provided within such cooperation. The relevant MESU order No. 1507, dated November 20, 2017 (Order 1507, 2017), includes, among other things, the establishment of a corresponding register of international technical programs and projects.

This Procedure defines an international scientific-technical project as a set of interconnected tasks aimed at researching, developing, improving, and implementing scientific and technical achievements conducted jointly by Ukrainian and foreign scientists in accordance with Ukrainian legislation. At the same time, an international scientific-technical program is defined by the Procedure as the organizational framework, established by regulations, for implementing international scientific-technical projects united to achieve a common goal within the priority areas of science and technology development of partner countries. It is clear that, according to the Procedure, projects and programs subject to MESU registration must be formed according to Ukrainian legislation.

The Procedure also defines a grant as financial or other resources provided free of charge by foreign states and international organizations to support the development of the material and technical base for conducting scientific and scientific-technical activities, carrying out specific fundamental or applied scientific research, scientific-technical or experimental developments, including the payment of wages to scientific and academic personnel as part of their work, according to the directions and conditions specified by the grant providers (Order 1507, 2017).

Additionally, the Procedure authorizes the Ukrainian Institute of Scientific and Technical Expertise and Information (UkrISTEI) to handle the technical processing of documents related to the preparation of international technical programs and projects for registration, as well as maintaining their registry, and preparing and issuing relevant informational materials. The Procedure outlines the documentation requirements for submission to UkrISTEI to conduct state registration and accounting of international technical programs and projects, including the required registration card as per the form attached to the Procedure.

The Procedure mandates an annual analysis by UkrISTEI of registered international technical programs and projects, the preparation of relevant conclusions on the state of international scientific-technical cooperation by this institute, and submission of a report to MESU (Order 1507, 2017). In addition to this Procedure, attention should also be given to the model contract form for performing research work based on the results of competitive selections of research projects within bilateral international scientific-technical and scientific-technological cooperation, approved by MESU Order 376 dated March 21, 2024 (Order 376, 2024).

This model contract was developed by the Directorate of Science Development in Order No. 317 dated March 13, 2024 (Order 317, 2024), which also approved the Action Plan for implementing international scientific and scientific-technical programs and projects in accordance with Ukraine’s international agreements under budget program 2201380, "Fulfillment of Ukraine's obligations in the field of international scientific-technical and educational cooperation, participation in the European Union Framework Program for Research and Innovation," in relevant directions and sub-directions for 2024. The Plan includes the titles of relevant programs, regulatory grounds, and funding for 2024-2025, with nine specific funding directions outlined.

For instance, 398 thousand UAH from the state budget is allocated for activities within the International European Innovation Scientific-Technical Program "EUREKA," and another 3,895.9 thousand UAH for the NATO program "Science for Peace and Security." The remaining seven areas cover bilateral intergovernmental scientific-technical cooperation conducted based on corresponding bilateral agreements and the protocols of meetings of bilateral commissions that operate under these agreements.

Thus, 1,990,000 UAH is allocated for Ukrainian-Austrian scientific cooperation, 5,970,000 UAH for Ukrainian-Lithuanian cooperation, 1,990,000 UAH for Ukrainian-Latvian cooperation, 2,985,000 UAH for Ukrainian-Polish cooperation, 1,592,000 UAH for Ukrainian-Turkish cooperation, 796,000 UAH for Ukrainian-Israeli cooperation, and another 5,970,000 UAH for Ukrainian-German cooperation (Order 317, 2024). Notably, some protocols of bilateral commissions regarding the respective funding for 2025 were already signed in 2022.

It should be noted that, unlike these documents, other MESU departmental acts do not provide for external funding or consider the impact of international agreements, programs, or projects. An example of such a document is the Regulation on the Competitive Selection of Scientific-Technical (Experimental) Developments at the MESU by State Order, approved by MESU Order 192 on February 9, 2017, both in its original edition and in the version amended by MESU Order No. 507 on April 12, 2024 (Order 192, 2017).

Conclusions

It can thus be stated that Ukrainian legislation on program management does not regulate aspects of international scientific cooperation and international scientific-technical collaboration. Existing programmatic and organizational acts as part of Ukraine's legislation on science and scientific activities demonstrate significant inconsistency both in defining the role and functions of international agreements on scientific cooperation and in outlining the roles of international programs and projects.

The main regulator in this area is the relevant ministry, which raises considerable debate over the issue of academic freedom. Additionally, national priorities for scientific research, criteria for the effectiveness of scientific activities, and protocols for international programs are largely governed by Ukrainian by-laws, and these are rather inconsistently *coordinated*.

These challenges not only further restrict the practical capacity of domestic institutions for academic freedom but also reduce the effectiveness of the relevant regulatory framework for international scientific cooperation, which is an obviously negative factor in the current conditions.

Further Scientific Research

The aspects of implementing international standards for regulating scientific and scientific-technical activities and scientific collaboration in Ukraine within national programmatic and management documents are of paramount importance. The subsequent evolution of relevant programmatic models, along with their doctrinal, financial, and staffing reflections and content, should become a matter for separate additional scientific exploration.

At the same time, one should not overlook the forms and methods for incorporating the requirements of EU program documents regarding the standards for organizing scientific activities into Ukraine’s programmatic acts (European Union, 2024; European Union, 2003). Moreover, the programmatic dimension of implementing international standards in Ukraine's scientific collaboration processes presents a significant systemic challenge. Concurrently, the current doctrinal analysis of legal program regulation is highly fragmented (Babin, 2008; Babin, Krolenko, & Klochkov, 2010).

The Law of Ukraine "On Scientific and Technical Information" dated June 25, 1993, No. 3322-XII (Law 3322-XII, 1993) provides for a somewhat broader dimension of international interaction. Additionally, this document mentions foreign sources of reference and information funds and foreign scientific and technical information in the list of primary tasks of the national system of scientific and technical information. International cooperation in this area, mentioned in Chapter VI of this law, should occur in the forms of international informational activities and intergovernmental exchanges of scientific and technical information, which must also be coordinated by the national information center. Law No. 3322-XII further refers to the licensing and quota regulation of scientific and technical information that may be used outside Ukraine for the production of weapons, military equipment, and science-intensive products (Law 3322-XII, 1993).

Related to this norm are the requirements of the Law of Ukraine "On State Regulation of Activities in the Field of Technology Transfer" dated September 14, 2006, No. 143-V (Law 143-V, 2006), which meticulously defines the format of international cooperation in the field of technology transfer in Article 5. At the same time, the Law of Ukraine "On Innovative Activities" dated July 4, 2002, No. 40-IV, practically does not mention the international dimension, only including in Article 3 the principles of state innovation policy measures to support international scientific and technological cooperation and mentioning in Article 23 relevant international agreements (Law 40-IV, 2002). Similarly, the Law of Ukraine "On a Special Regime for Innovative Activities of Technological Parks" dated July 16, 1999, No. 991-XIV (Law 991-XIV, 1999) refers exclusively to customs duties in the context of international cooperation.

These conditions only sharpen the relevance of a systematic search for effective forms and models to counter destructive manifestations and provocations from the aggressor state, which should include further review and revision of bilateral programs and projects concluded by Ukraine in the scientific sphere, as well as re-evaluation of the corresponding management activities. This systematic counteraction should also encompass negative trends in European scientific structures, particularly regarding the misuse of relevant programmatic and project models of scientific collaboration (Tytska, & Babin, 2023; Babin, & Chvaliuk, 2021; Babin, Plotnikov, & Prykhodko, 2023b) that have been implemented by Ukraine.

Therefore, the current issue of the subsequent systemic and comprehensive improvement of mechanisms for implementing international standards of scientific work and scientific-technical activities under domestic conditions, to effectively counter such provocations from destructive forces on the international stage (Babin, 2023; 2022a; 2022b; 2024), acquires particular significance. Furthermore, the relevant evolution of the corresponding comprehensive doctrinal development regarding the situation of implementing programmatic and project subcodes standards into national law in scientific activity will obviously influence the dynamics of the scientific foundation for further unconditional processing of special universal and European international agreements concerning the future regulation of scientific activities.

Bibliographic references

Achermann, K., & Besson, S. (2023). International cooperation under the human right to science: What and whose duties and responsibilities? *Frontiers in Sociology, 8*, 1-17.

Babin, B. (2008). *International programs as a tool of resisting ethnic discrimination. Foundation of Regional Initiatives*. OSCE. Retrieved from https://www.osce.org/ru/odihr/33808

Babin, B. (2019). Health Care for Crimean Residents: Interstate Conflict Challenges and Possible Legal and Organisational Solutions. *Medical News, 12*, 2441-2444.

Babin, B. (2022a). Legal Assessment of Russian Ongoing Aggression in the Black and Azov Seas. *Baltic Rim Economies, (2)*, 27-30.

Babin, B. (2022b). *Prosecution of Ecocide as a Weapon in Armed Conflict: Reflections on Crimea*. International Crimes Database project. Retrieved from https://www.internationalcrimesdatabase.org/Commentary/IcdBriefs2022

Babin, B. (2023). Water Scarcity in Crimea and the Ecological Catastrophe in the Black Sea. *Crimea from Regional and International Perspectives, 1*, 97-114.

Babin, B. (2024). Danube, Eurointegration, and Russian Naval Aggression. *Baltic Rim Economies, 1*, 38-58.

Babin, B., & Chvaliuk, A. (2021). *Crimean Space Facilities: Global Challenges*. Association of Reintegration of Crimea. Retrieved from https://arcrimea.org/en/investigations/2021/09/11/crimean-space-facilities-global-challenges-september/

Babin, B., Chvaliuk, A., & Plotnikov, O. (2021a). Attempted Annexation of Crimea and Maritime Environment Legal Protection. Lex Portus, 7(1), 31–52.

Babin, B., Chvaliuk, A., & Plotnikov, O. (2021b). Epidemiologic Activities in the Modern Crimea: Humanitarian Challenges and Possible Solutions. *Medical News, (11)*, 2940-2945.

Babin, B., Krolenko, V., & Klochkov, V. (2010). *Program regulation as a tool of the human dimension and sustainable development in the OSCE region*. Foundation of Regional Initiatives. OSCE. Retrieved from https://www.osce.org/ru/node/71655

Babin, B., Plotnikov, O., & Prykhodko, A. (2023a). Damage to the Maritime Ecosystems from the Destruction of the Kakhovka Dam and International Mechanisms of its Assessment. *Lex Portus, 9*(5), 19-22.

Babin, B., Plotnikov, O., & Prykhodko, A. (2023b). *Environmental Challenges of Occupation of Crimea and Other Forms of Russian Aggression*. Association of Reintegration of Crimea. Retrieved from https://acortar.link/pSD4IB

Besson, S. (2023). The 'Human Right to Science' Qua Right to Participate in Science: The Participatory Good of Science and its Human Rights Dimensions. *International Journal of Human Rights, 28*(4), 497-528.

Bridget, D.M. (2012). Science and Technology Agreements as Tools for Science Diplomacy: A U.S. Case Study. *Science & Diplomacy, 1*(4), 20-28. December 2012. Retrieved from https://acortar.link/eF8KpJ

Chvaliuk, A., Plotnikov, O., & Babin, B. (2023). *Russian Aggression in Ukraine and Ongoing Challenges for the Climate Changes*. ARC; UN Special Rapporteur on toxics and human rights. Retrieved from https://acortar.link/zqLNX5

European Union. (2003). *Agreement on scientific and technical cooperation between the EC and Ukraine*. Retrieved from https://acortar.link/o0CDKf

European Union. (2024). *Association to Horizon Europe. International cooperation, strategy, partner countries and regions, funding, project results, documents and news*. Retrieved from https://acortar.link/H5cKkj

Fikkers, D.-J., & Horvat, M. (2014). *Basic Principles for effective International Science, Technology and Innovation Agreements*. Luxembourg: Publications Office of the European Union.Retrieved from https://acortar.link/HKeWvX

Flink, T., & Schreiterer, U. (2010). Science diplomacy at the intersection of S&T policies and foreign affairs: toward a typology of national approaches. *Science and Public Policy, 37*(9), 665–677.

Law 143-V. On state regulation of activities in the field of technology transfer. *Verkhovna Rada of Ukraine,* 2006. Retrieved from https://zakon.rada.gov.ua/laws/show/143-16

Law 1621-IV. On state target programs. *Verkhovna Rada of Ukraine*, 2004. Retrieved from https://zakon.rada.gov.ua/laws/show/1621-15

Law 2623-III. On priority areas for the development of science and technology: Law. *Verkhovna Rada of Ukraine*, 2001. Retrieved from https://zakon.rada.gov.ua/laws/show/2623-14

Law 3322-XII. On scientific and technical information. *Verkhovna Rada of Ukraine*, 1993. Retrieved from https://zakon.rada.gov.ua/laws/show/3322-12

Law 3715-VI. On priority directions of innovative activity in Ukraine. *Verkhovna Rada of Ukraine*, 2011. Retrieved from Retrieved from https://zakon.rada.gov.ua/laws/show/3715-17

Law 40-IV. On Innovative Activities. *Verkhovna Rada of Ukraine*, 2002. Retrieved from https://zakon.rada.gov.ua/laws/show/40-15

Law 51/95-VR, On scientific and scientific-technical expertise. *Verkhovna Rada of Ukraine*, 1995. Retrieved from https://zakon.rada.gov.ua/laws/show/51/95-вр

Law 991-XIV. On the Special Regime of Innovative Activities of Technological Parks. *Verkhovna Rada of Ukraine,* 1999. Retrieved from https://zakon.rada.gov.ua/laws/show/991-14

Order 1104/580. On approval of the Regulation on the Interagency Coordination Council of the Ministry of Education and Science of Ukraine and the National Academy of Sciences of Ukraine on cooperation issues between Ukraine and the European Organization for Nuclear Research (CERN). *Ministry of Education and Science*, 2016, No. 1104/580. Verkhovna Rada of Ukraine. Retrieved from https://zakon.rada.gov.ua/laws/show/z1338-16

Order 13. On approval of the Procedure for awarding academic titles to scientific and scientific-pedagogical workers. *Ministry of Education and Science*, 2016. Retrieved from https://zakon.rada.gov.ua/laws/show/z0183-16#n14

Order 1469. On approval of the Regulation on the national contact point of the European Union's Framework Program for Research and Innovation "Horizon 2020". *Ministry of Education and Science*, 2016, No. 1469. Verkhovna Rada of Ukraine. Retrieved from https://zakon.rada.gov.ua/laws/show/z0005-17#Text

Order 1507. On approval of the Procedure for registering international scientific and technical programs and projects carried out within the framework of international scientific and technical cooperation by Ukrainian scientists, as well as grants provided within such cooperation. *Ministry of Education and Science*, 2017. Retrieved from https://zakon.rada.gov.ua/laws/show/z1564-17

Order 192. On approval of the Procedure for conducting a competitive selection of scientific and technical (experimental) developments at the state order by the Ministry of Education and Science of Ukraine. *Ministry of Education and Science of Ukraine*, 2004. Retrieved from https://zakon.rada.gov.ua/laws/show/z0339-17

Order 317. On some issues of implementing international scientific and technical programs and projects in 2024. *Ministry of Education and Science of Ukraine*, 2024. Retrieved from https://acortar.link/C5xvPZ

Order 376. On approval of the sample contract for the execution of research works based on the results of competitive selection of research projects under bilateral international scientific-technical and scientific-technological cooperation. *Ministry of Education and Science of Ukraine*, 2024. Retrieved from https://acortar.link/JabtT5

Order 919. On approval of the Procedure for conducting a competition for the selection of representatives and experts to committees responsible for monitoring the implementation of the European Union's Framework Program for Research and Innovation "Horizon 2020". *Ministry of Education and Science*, 2017. Retrieved from https://ips.ligazakon.net/document/view/RE30744

Plotnikov, O., Chvaliuk, A., & Babin, B. (2022). *Indigenous Peoples, Rural Areas and Water Crisis in the Crimea*. ARC; UN Special Rapporteur on the human rights to safe drinking water and sanitation. Retrieved from https://www.ohchr.org/sites/default/files/2022-01/Association-of-Reintegration-of-Crimea.pdf

Resolution 214. On approval of the Regulation on national contact points and the Coordination Center of the European Union's Framework Program for Research and Innovation "Horizon Europe" and the European Atomic Energy Community's Research and Training Program (2021-2025), complementary to the "Horizon Europe" program. *Cabinet of Ministers of Ukraine*, 2024. Retrieved from https://zakon.rada.gov.ua/laws/show/214-2024-п

Resolution 1029. On the implementation of an experimental project on the development of autonomy for some higher education institutions. *Cabinet of Ministers of Ukraine*, 2024. Retrieved from https://zakon.rada.gov.ua/laws/show/1029-2024-п

Resolution 476. On approval of the list of priority thematic areas of scientific research and scientific-technical developments for the period until December 31 of the year following the termination or cancellation of martial law in Ukraine. *Cabinet of Ministers of Ukraine*, 2024. Verkhovna Rada of Ukraine. Retrieved from https://zakon.rada.gov.ua/laws/show/476-2024-п

Resolution 540. On approval of the Procedure for state attestation of research institutions and higher education institutions in terms of their scientific (scientific-technical) activities. *Cabinet of Ministers of Ukraine*, 2017. Retrieved from https://zakon.rada.gov.ua/laws/show/540-2017-п

Resolution 630. On approval of the Regulation on the Ministry of Education and Science of Ukraine. *Cabinet of Ministers of Ukraine*, 2014. Retrieved from https://zakon.rada.gov.ua/laws/show/630-2014-п

Resolution 703. Some issues of centers for collective use of scientific equipment. *Cabinet of Ministers of Ukraine*, 2022. URL: https://zakon.rada.gov.ua/laws/show/703-2022-п

Romano, C., & Boggio, A. (2024). *The Human Right to Science. History, Development, and Normative Content*. Oxford: Oxford University Press.

Rüffin, N. (2021). *B-STA-R: A repository for bilateral science and technology agreements*. WZB – Berlin Social Science Center. Retrieved from https://doi.org/10.7802/2310

Rüffin, N., & Schreiterer, U. (2017). *Science and Technology Agreements in the Toolbox of Science Diplomacy: Effective Instruments or Insignificant Add-ons?* Working paper. Retrieved from https://zenodo.org/records/891199

Shaver, L. (2010a). The Right to Science and Culture. *Wisconsin Law Review, 1*, 121–84. Retrived from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1354788

Shaver, L. (2015b). The Right to Science: Ensuring that Everyone Benefits from Scientific and Technological Progress. *European Journal of Human Rights, 4*, 411–430.Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2564222

Tytska, Y., & Babin, B. (2023). *Russian Aggression in Ukraine and Violation of Rights to Science*. ARC; UN Special Rapporteur in field of cultural rights. Retrieved from https://acortar.link/9W3xHE

Tytska, Y., & Babin, B. (2024). *Russian Aggression in Ukraine and Repressions against Academic Freedoms*. ARC; UN Special Rapporteur on the right to education. Retrieved from https://acortar.link/KDoZfM

Xanthaki, A. (2024). *Right to participate in science. Report of the Special Rapporteur in the field of cultural rights A/HRC/55/44*. Human Rights Council 55th session. Retrieved from https://acortar.link/nYQ1iT

Check for updates

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.14

Cómo citar:
Gubaryeva, O., Herasymchuk, T., Voronova, Y., & Yarmak, T. (2024). Methods for developing psychological resilience in engineering students under stressful conditions. *Revista Eduweb*, *18*(4), 205-218. https://doi.org/10.46502/issn.1856-7576/2024.18.04.14

Methods for developing psychological resilience in engineering students under stressful conditions

Métodos para desarrollar la resistencia psicológica en estudiantes de ingeniería bajo condiciones estresantes

Olga Gubaryeva
https://orcid.org/0000-0002-5303-674X
olgagubar@gmail.com
Candidate of Psychological Sciences, Associate Professor, Department of Philosophy and Pedagogy of Vocational Training, Kharkiv National Automobile and Highway University, Kharkiv, Ukraine.

Tetiana Herasymchuk
https://orcid.org/0000-0002-1952-4977
tetianapvl872@gmail.com
Candidate of Pedagogical Sciences, Associate Professor, Department of Philosophy and Pedagogy of Vocational Training, Kharkiv National Automobile and Highway University, Kharkiv, Ukraine.

Yelizaveta Voronova
https://orcid.org/0000-0001-9786-9906
volonovayel@gmail.com
Associate Professor, Department of Philosophy and Pedagogy of Vocational Training, Kharkiv National Automobile and Highway University, Kharkiv, Ukraine.

Tetiana Yarmak
https://orcid.org/0000-0003-4140-8283
tetyarmak@gmail.com
Candidate of Sociological Sciences, Associate Professor, Department of Philosophy and Pedagogy of Vocational Training, Kharkiv National Automobile and Highway University, Kharkiv, Ukraine.

Recibido: 20/10/24
Aceptado: 21/12/24

Abstract

This study focuses on the important topic of developing psychological resilience in students. The aim of the research is to explore methods for enhancing the psychological resilience of engineering students under stressful conditions. The following methods were used in the study: psychological diagnostics, quantitative, qualitative, and comparative data analysis, and modeling. Diagnostic indicators of psychological resilience include psychological resourcefulness, resilience, and stress tolerance. The study found that engineering students mostly showed low to medium levels in the analyzed parameters. Based on empirical data, a developmental and corrective program was designed to enhance the psychological resilience of students. The program includes various methods such as relaxation, meditation, breathing exercises, reframing, spiritual practices, sports activities, anxiety-reducing mobile apps, motivational videos, and more. These methods were implemented in group training sessions and other forms of group work with technical students. The results of this study can be used in higher education institutions to support the development of students' psychological resilience. Future

research will focus on creating recommendations for developing resilience in technical students under stressful conditions.

Keywords: emotions, mental state, psychological support, stress, students, technical specialties.

Resumen

Este estudio se centra en el importante tema del desarrollo de la resiliencia psicológica en los estudiantes. El objetivo de la investigación es explorar métodos para mejorar la resistencia psicológica de los estudiantes de ingeniería en condiciones de estrés. En el estudio se utilizaron los siguientes métodos: diagnóstico psicológico, análisis de datos cuantitativos, cualitativos y comparativos, y modelado. Los indicadores diagnósticos de la resiliencia psicológica incluyen el ingenio psicológico, la resiliencia y la tolerancia al estrés. El estudio encontró que los estudiantes de ingeniería mostraron niveles bajos a medios en los parámetros analizados. Sobre la base de datos empíricos, se diseñó un programa de desarrollo y corrección para mejorar la resiliencia psicológica de los estudiantes. El programa incluye varios métodos como relajación, meditación, ejercicios de respiración, reencuadramiento, prácticas espirituales, actividades deportivas, aplicaciones móviles para reducir la ansiedad, videos motivacionales y más. Estos métodos se aplicaron en sesiones de formación grupales y otras formas de trabajo en grupo con estudiantes técnicos. Los resultados de este estudio pueden utilizarse en instituciones de enseñanza superior para apoyar el desarrollo de la resistencia psicológica de los estudiantes. La investigación futura se centrará en crear recomendaciones para desarrollar la resiliencia en estudiantes técnicos bajo condiciones estresantes.

Palabras clave: emociones, estado mental, apoyo psicológico, estrés, estudiantes, especialidades técnicas.

Introduction

In modern conditions, individuals are exposed to significant negative impacts, which have destructive effects on their mental and emotional states. Ukrainians' psycho-emotional well-being during the war is affected by daily threats to life and health, the risk of losing loved ones, property, jobs, familiar social circles, and more. Many also suffer the effects of prolonged psychological trauma, loss, or grief. These conditions are especially destructive to individuals who are still developing, acquiring knowledge, and preparing for adult life, such as Ukrainian students. In the context of war, they are forced to study in various formats, change their usual means of communication, and, in some regions, even relocate. Constant threats to life and health, difficult tasks, and uncertainty significantly deplete students' psychological resources. Under such conditions, the need to develop psychological resilience becomes increasingly important. This is a crucial psychological phenomenon that affects a person's ability to withstand stress while maintaining mental health, which is essential for both personal life and academic and professional activities. Psychological resilience is developed and adjusted throughout life. Its indicators include a person's ability to control emotions and maintain normal psycho-emotional and physical states in stressful situations. Students are especially vulnerable to stress because their personalities are still forming. Therefore, the development of resilience in students under stress is an important task for psychological support. Despite a number of studies on the development of psychological resilience, there is a lack of practical solutions in the scientific literature. This highlights the direction of current research.

The importance of the study is undermined by the fact that Ukrainian students faced exceptionally stressful conditions in research and life in general. For more than 2 years, a full-scale military invasion of Ukraine has been going on, so students from 6 regions are generally deprived of the opportunity of full-time education, and different formats of education are combined in other regions of Ukraine. Over 131 professional-pedagogical and higher education institutions in Ukraine are significantly damaged or destroyed. Sixteen institutions of higher education were reloaded from the combat zone. Also, due to the war, thousands of students went abroad, and some continue to study in Ukraine online (Sharov, 2022). In addition, due to hostilities and forced migration, almost 24 thousand students did not resume their studies. Also, the learning conditions of international students in Ukraine have become more complicated, the

number of which reaches 50 thousand people and has decreased compared to the beginning of 2022 to 34 thousand (Rebryk, 2024).

Constant threats of missile and drone attacks will force Ukrainian students to be constantly distracted from learning in any format, to interrupt communication with teachers and the audience to go to safe places to shelter. Therefore, to adequately respond to these challenges, it is essential to form the psychological stability of students. We define the psychological resilience of students under stress as the ability of educational applicants to adapt to extreme circumstances, overcome anxiety, maintain emotional and psychological well-being, and support practical activities and training in war. In none of the countries of the world, there are no effective practices for preserving the psychological stability of students in war since there were such precedents. Therefore, our research should fill the gap regarding the preservation of the psychological stability of students in critical, highly stressful conditions. Several Ukrainian scientists have studied the psychological stability of personality (Moskalenets & Fedyk, 2024; Klochkov, 2022). They confirm its relevance and correlation with the psychological resources of the individual (Yena, 2024; Kostryba, & Lyashko, 2023). However, the duration of the above-mentioned stressful events necessitates further scientific research in this direction. It is also essential to search for effective practices and methods for the development of the psychological stability of students in stressful conditions.

Hypothesis: The use of well-selected methods of psychological support can enhance students' psychological resilience in stressful conditions. Objective: To identify methods for developing psychological resilience in engineering students under stressful conditions. Research tasks:

- Determine the current level of psychological resilience in engineering students;
- Develop programs to enhance psychological resilience in engineering students under stress;
- Test the effectiveness of the program;
- Assess the level of resilience achieved by the students.

Literature Review

Scientists describe the impact of stress on the mental health of student youth as one of the most destructive consequences of war. This influence negatively affects students' physical health parameters, depriving them of opportunities for development and essential resources. In this context, psychological resilience becomes crucial. It is viewed as resistance to stress, a safeguard against disorientation and various disorders, and a foundation for inner harmony, full mental health, and high productivity (Dekusar & Davidova, 2024). Psychological resilience is considered a dynamic component of personality structure. It enables individuals to withstand extreme situations, life difficulties, and adverse conditions while maintaining physical and mental health, as well as performance (Klochkov, 2022). Scientists emphasize the particular vulnerability of student youth to the intense destructive impact of war-related stressors on their psyche (Moskalenets & Fedyk, 2024). Psychological resilience, which is influenced by both genetically determined and psychological components of personality, is essential for countering this influence (Kostryba & Lyashko, 2023). The development of psychological resilience is achieved by forming a psychological resource within the individual (Yena, 2024).

Scientific studies highlight the negative impact of stress factors on students' mental health and emphasize the need to seek and implement new activities (Zhang, et al., 2022). These may include various types of sports, scientific, and artistic activities (Al-Rousan et al., 2023). Researchers stress the importance of social support for higher education students to preserve their mental health under stress (Pasinringi et al., 2022). Empirical studies conducted among students revealed a tendency toward increased depression, anxiety, acute stress symptoms, and neurotic disorders among students during the prolonged war in Ukraine (Mykhaylyshyn et al., 2024). Indicators of mental instability in students under stress include reduced emotional well-being and inappropriate reactions to environmental stressors (Yunusovich et al., 2022). Stress also has a destructive impact on students' academic self-efficacy, highlighting the need for a healthy atmosphere to support their future development (Liu et al., 2024). Therefore, authors of empirical studies emphasize the importance of mitigating the effects of students' emotional disorders through the

implementation of corrective physical activities (Byshevets et al., 2024). It is also crucial to develop personal adaptation potential, the ability to devise stress-coping strategies, and improve students' subjective psychological well-being (Babakhova et al., 2023).

Numerous studies demonstrate a correlation between stress and poor mental well-being in students, confirmed by the global scientific community during the COVID-19 pandemic (Barbayannis et al., 2022; Fang et al., 2022). This underscores the importance of further research into the academic and social factors contributing to the development of anxiety and depressive disorders in students under stress (Limone & Toto, 2022). In this context, reducing stress levels, increasing the educational influence on students, maintaining a positive family environment, fostering a supportive social atmosphere, and providing psychological counseling are critical (Fan et al., 2024). Research also confirms the positive influence of psychosocial resources on the development of students' psychological resilience (Kee-Jiar & Chia-Keat, 2020). Individual factors (resilience and positivity) and socio-environmental factors (social support and nationality) are identified as resources that reduce perceived stress levels among university students (Litwic-Kaminska et al., 2023). Reducing stress is seen as a tool to protect students' mental health from negative influences (Slimmen et al., 2022).

Stress in students correlates with anxiety, as confirmed by physiological indicators such as increased heart rate and cortisol secretion (Wang et al., 2024). Stress also affects students' academic self-efficacy (Kristensen et al., 2023) and is a factor in their psychological well-being (Feng et al., 2024; Makhubela, 2022). To overcome stress, students need to develop psychological resilience (Theron et al., 2022; Sarbassova et al., 2024). This is confirmed by research on the psychogenic impact of extreme situations on an individual's stress resilience. Psychological resilience depends on individual personality traits (self-regulation, self-control, emotional stability, and emotional intelligence) and facilitates adaptation to environmental conditions while mitigating their negative effects (Spytska, 2024). During the external migration of Ukrainian students amid the war, the influence of cultural stress also increases, triggering symptoms of depression, anxiety, and behavioral deviations (Schwartz et al., 2024). Amid negative social challenges, the issue of psychological resilience is relevant not only for students but also for teachers. One way for teachers to address this situation is through self-development, experience exchange, and participation in consulting programs (Igar, 2024). Psychological support for students in stressful conditions should include optimizing personal psychological resources for successfully overcoming stress. It should also focus on minimizing the negative effects of stress and developing strong methods of defensive behavior and coping (Kundii et al., 2024). Methods for developing students' psychological resilience in stressful conditions include group sessions, training, and teaching relaxation techniques, stress management, positive thinking, and other psychological strategies (Yena, 2024).

Overall, scientific research emphasizes the importance of developing students' psychological resilience. Significant attention is also given to the impact of stress factors on students' mental health. However, most studies focus on the influence of stress factors on individual psychological resilience. At the same time, the issue of finding effective methods for developing students' psychological resilience in modern stressful conditions remains less explored. Therefore, there is a need for empirical verification of methods for developing students' psychological resilience under stress.

Methods

Research Procedure

The study on the development of psychological resilience in students of engineering disciplines consisted of four stages. In the first stage (organizational), a sample was formed, and psychodiagnostic tools were selected. During the second stage (diagnostic), psychological testing was conducted. In the third stage (developmental), a program to enhance students' psychological resilience in stressful conditions was developed and tested. The fourth stage (final) involved retesting the respondents, interpreting and comparing the obtained data, and drawing conclusions. The study was conducted from December 2023 to

September 2024: December 2023 – organizational and diagnostic stages; January to June 2024 – developmental stage; September 2024 – final stage.

Sample Formation

The study on the development of psychological resilience in engineering students was conducted at the Department of Philosophy and Pedagogy of Professional Training at the Faculty of Transport Systems of Kharkiv National Automobile and Highway University. The study covered 175 first- to fourth-year students (1st year – 40 students, 2nd year – 50 students, 3rd year – 45 students, 4th year – 40 students). Personal data of the respondents were kept confidential, making the survey anonymous. The use of valid psychodiagnostic methods ensured objectivity in conducting the survey. During the formation of the sample, the goal was to include as many engineering students from all years of study as possible to track the dynamics of changes in psychological resilience under stressful conditions at each year of study. This approach also allowed for considering the impact of the psychological work carried out with the students to improve their resilience in stressful conditions. The sample size was sufficient for the study, as it included the majority of students from the analyzed disciplines. The surveys were conducted by practical psychologists.

Methods

The following methods were chosen to study the level of psychological resilience in engineering students:

Psychodiagnostic methods: O.S. Shtepa's "Personality Resourcefulness Questionnaire," (Shtepa, 2018);
the "Connor-Davidson Resilience Scale" (CD-RISC-10), modified by L. Campbell-Sills and M.B. Stein (Shkolina, et al., 2020);
T. Holmes and R. Rahe's "Stress Resistance and Social Adaptation" test (Holmes, & Rahe,1967);
qualitative analysis of psychodiagnostic data.

Ukrainian researchers developed and successfully tested the questionnaire on the psychological resourcefulness of O.S. Shtepa (Shtepa, 2018). The methodology consists of 67 statements that involve the expression of consent or disagreement by the respondents. The method has been successfully validated, particularly the value. In particular, the Cronbach α is > 0.7. The methodology provides answers to questions on several scales: self-confidence, kindness to people, helping others, success, love, openness to relationships and life, creativity, faith in goodness, desire for wisdom, work on oneself, self-realization in the profession, responsibility, knowledge of one's psychological resources, ability to update one's psychological resources, independently overcome challenging life situations. According to this technique, the individual's general level of psychological resourcefulness is also recognized.

"Resistance Scale" by K. Connor-D. Davidson, modified by L. Campbell-Seals and M. Stein (L. Campbell-Sills, M. B. Stein CD-RISC-10), contains 10 statements assessing a person's ability to adapt to stressful situations, overcome difficulties and recover from them. Respondents are asked to rate ten statements on a scale from 0 to 4 points, where 0 - "completely disagree" and 4 - "completely agree." The scale measures the following key components of resistance: stress resistance, the ability to control the situation, self-confidence, and the ability to recover from difficult circumstances quickly. The technique allows you to establish high, medium and low resistance levels. With a high level of resistance, the individual has a pronounced psychological stability and the ability to adapt to life's challenges effectively. A person with an average level of resiliency has the potential to develop resilience further. Still, with a low level, they have difficulties in confronting stress and the need for additional support and resources. Resistance scale by K. Connor-D. Davidson was modified by L. Campbell-Seals and M. Stein and adapted by Ukrainian scientists (Shkolina et al., 2020). Studies have confirmed the reliability of the Ukrainian version of this technique by alpha-Cronbach 0, 755 results.

The study used the original method, "Determination of stress resistance and social adaptation" by T. Holmes, R. Rage (Holmes & Rahe, 1967). It consists of 43 life events, each with a specific weight coefficient of stress,

expressed in points. Examples of such events are marriage, divorce, death of a loved one, change of workplace, etc. The respondent analyzes the list of events and notes those that happened to him during the last year. After that, the total number of points is calculated, and the corresponding stress resistance and social adaptation levels are determined: high, marginal, and low.

Results

The basis for the formation of personal psychological resilience is psychological resources. The average data obtained at the diagnostic stage of the study, based on O.S. Shtepa's "Personality Psychological Resources Questionnaire," are presented in Table 1.

Table 1.
Summary Data on the Level of Psychological Resources Among Engineering Students in 1st to 4th Years, %

Level of Psychological Resources	1st Year	2nd Year	3rd Year	4th Year	Average Indicator
High	12.5	20	35.6	50	29.5
Medium	37.5	40	42.2	30	37.4
Low	50	40	22.2	20	33.1

Source: compiled by the authors based on the conducted research

Based on the data in Table 1, it can be stated that most respondents have an average level of personal psychological resources. The highest levels of psychological resources are recorded in the third and fourth years of study. This can be explained by the increased adaptability of engineering students to life and study in stressful conditions (changing study formats, interruptions due to mass missile strikes, problems with energy supplies and the internet, etc.). The lowest levels of psychological resources are found among first- and second-year students. This is associated with their lower adaptation to studying and living under constant stress and psychological trauma. Low levels of personal psychological resources indicate insufficient capacity for developing psychological resilience in stressful conditions. We also analyzed personal psychological resource indicators across all subscales of O.S. Shtepa's "Personality Psychological Resources Questionnaire." The data are presented in Table 2.

Table 2.
Indicators of Psychological Resources Among Engineering Students in 1st to 4th Years, % by Subscale

Subscale	% respondents				Average Indicator
	1st Year	2nd Year	3rd Year	4th Year	
1. Self-confidence	12.5	16	22.2	50	25.2
2. Kindness towards others	5	4	13.3	20	10.6
3. Helping others	17.5	16	17.8	20	17.8
4. Success	5	12	22.2	35	18.6
5. Love	15	16	15.6	25	17.9
6. Creativity	2.5	4	17.8	37.5	15.4
7. Faith in goodness	2.5	4	13.3	20	10.0
8. Aspiration for wisdom	2.5	4	11.1	25	10.7
9. Self-development	10	20	28.9	45	26.0
10. Professional selfrealization	5	16	31.1	47.5	24.9
11. Responsibility	10	16	22.2	55	25.8
12. Awareness of one's own psychological resources	2.5	12	26.7	50	22.8
13. Ability to renew one's psychological resources	5	16	24.4	45	22.6
14. Ability to manage one's psychological resources	2.5	14	17.8	40	18.6

Source: compiled by the authors based on the conducted research

As shown in Table 2, engineering students demonstrated the highest psychological resource indicators across four subscales: self-development (26%), responsibility (25.8%), self-confidence (25.2%), and professional self-realization (24.9%). Slightly lower indicators were recorded for awareness of one's own psychological resources (22.8%), the ability to renew them (22.6%), the ability to manage them (18.6%), success (18.6%), love (17.9%), and helping others (17.8%). The lowest indicators of psychological resources were found in the subscales: faith in goodness (10%), aspiration for wisdom (10.7%), kindness towards others (10.6%), and creativity (15.4%). This suggests that students are capable of self-development and have a responsible attitude towards themselves and life. Respondents are confident in themselves and already feel professionally self-realized at the stage of study. However, they exhibit less kindness towards others, a desire for wise decisions, and creative activity. Within the empirical study, we diagnosed the resilience of individuals, i.e., their resistance to stress factors. The diagnostic results are presented in Figure 1.

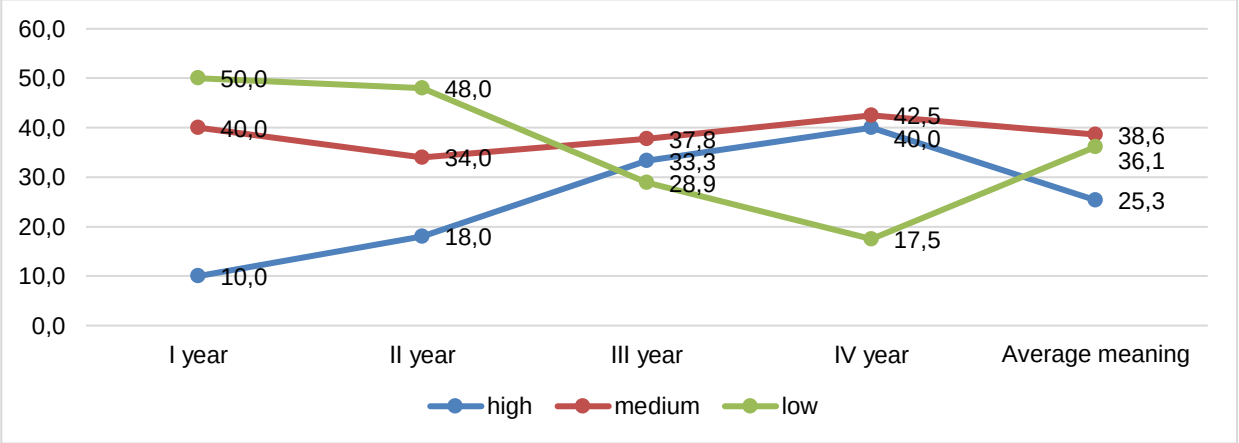

Figure 1. Levels of Resilience Among Engineering Students in 1st to 4th Years, %
Source: compiled by the authors based on the conducted research

Empirical data (Figure 1) indicate an average level of resilience in most of the surveyed students. A significant portion consists of students with low resilience, indicating major difficulties in developing psychological resilience under stress. The lowest indicators of this parameter were recorded among first- and second-year students. This suggests a low ability among these students to cope with stress while maintaining a normal mental state and capacity for learning. However, the indicators are higher for third- and fourth-year students compared to younger students. This indicates that these students can counter stress by utilizing their internal psychological resources, maintaining stable psycho-emotional states, and productivity.

The ability to resist stress reflects personal psychological resilience and the potential for its further development and enhancement. The empirical data obtained using the Holmes and Rahe Stress Resistance and Social Adaptation Scale are summarized in Figure 2.

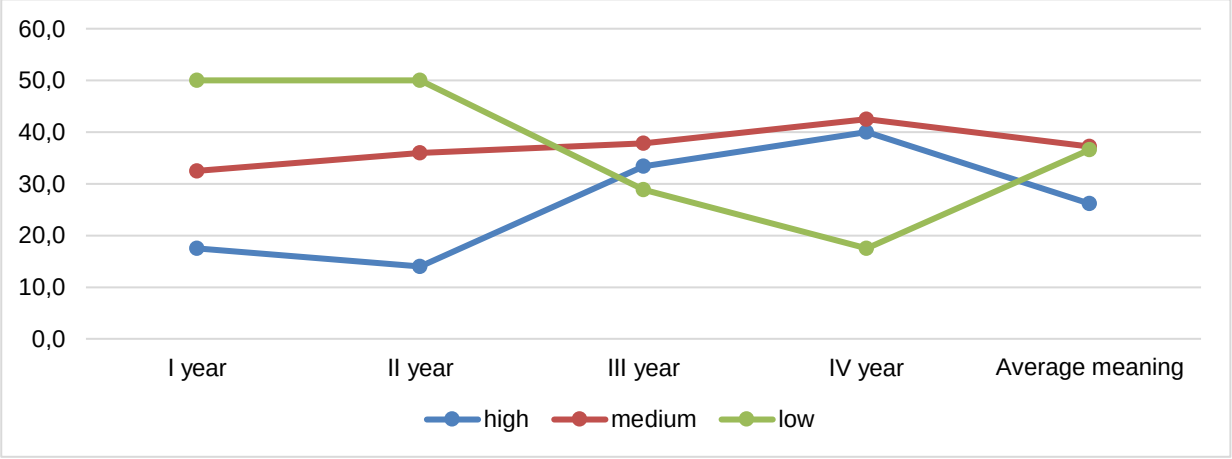

Figure 2. Degree of Stress Resistance Among Engineering Students in 1st to 4th Years, %
Source: compiled by the authors based on the conducted research

Empirical data (Figure 2) show that most of the sample consists of students with a low level of stress resistance, indicating significant problems in the development of psychological resilience in stressful conditions.

As part of the study, we proposed a program to develop psychological resilience among students in stressful conditions. Its goal is to form and adjust personal psychological resilience.

The objectives of the program for the development of psychological resilience among technical students include adjusting students' stress resistance, enhancing personal psychological resources, and adjusting student resilience.

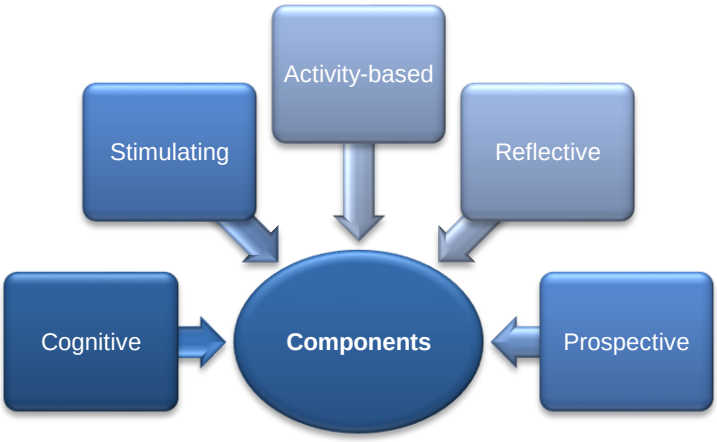

Figure 3. Structure of the Developmental-Corrective Program for Enhancing Psychological Resilience among Technical Students in Stressful Conditions.
Source: Compiled by the authors based on the conducted research.

The program for developing psychological resilience in technical students consists of cognitive, stimulating, active, reflective, and prospective components (Figure 3). The cognitive component aims to expand the cognitive domain of students, deepening their knowledge of psychological resilience in stressful conditions. The goal of the stimulating component is to motivate students to activate their own psychological resources in stressful situations. The active component is designed to form an objective understanding of one's own

level of psychological resilience. The reflective component focuses on comparing students' current and required levels of psychological resilience. The prospective component is aimed at planning further activities to develop psychological resilience among students.

To enhance the psychological resilience of technical students, we proposed the following methods within the program: psychological exercises; breathing exercises; autogenic training; relaxation; art therapy; humor; "havening" (safe zone); reframing; mindfulness; gratitude practices; working with web services to reduce anxiety and emotional tension; spiritual practices; creative activities; and creating motivational videos. Based on the aforementioned methods, we have developed a series of activities for the developmental-corrective program. The themes of these activities are presented in Table 3.

Table 3.
Themes of Activities in the Developmental-Corrective Program for Enhancing Psychological Resilience among Technical Students

No.	Theme	Methods	Form of Conduct
1	How to Cope with Stress	Psychological exercises, autogenic training, breathing exercises	Group discussion
2	Adjusting Psycho-Emotional State	Psychological exercises, relaxation, meditation, reframing	Psychological training with elements of reframing
3	Ways to Counteract Stress	Art therapy, creative exercises, humorous stories, "havening"	Group discussion with elements of storytelling
4	Stress and Digitalization	Meditation, mindfulness, analysis of spiritual practices, working with web applications to reduce anxiety (Svitlo, Mindshift, Booster Buddy, Daylio, Drug. First Aid)	Psychological training
5	Psychological Resilience and War	Training, physical exercises, gymnastics, creating motivational videos, relaxation exercises, gratitude practices	Sports-relaxation competition
6	How to Become a Psychologically Resilient Person	Autogenic training, meditation, creative exercises	Group discussion with elements of storytelling
7	My Psychological Resource	Art therapy, creative exercises, humorous stories, reframing	Psychological training
8	My Action Plan in Stress	Meditation, creative exercises, projective exercises	Group discussion with elements of storytelling

Source: Compiled by the authors based on the conducted research.

The described program was implemented in the psychological support system for technical students of all academic years during the formative stage of the research. It was carried out during the II semester of the 2023/2024 academic year. After the experimental testing of the program we developed, a repeat psychodiagnosis was conducted at the final stage of the research using the same methods as in the initial stage. Based on the obtained data, a comparative analysis of the data from the initial and final stages of the research was performed. The comparison was based on the averaged data obtained. The results are presented below (Fig. 4).

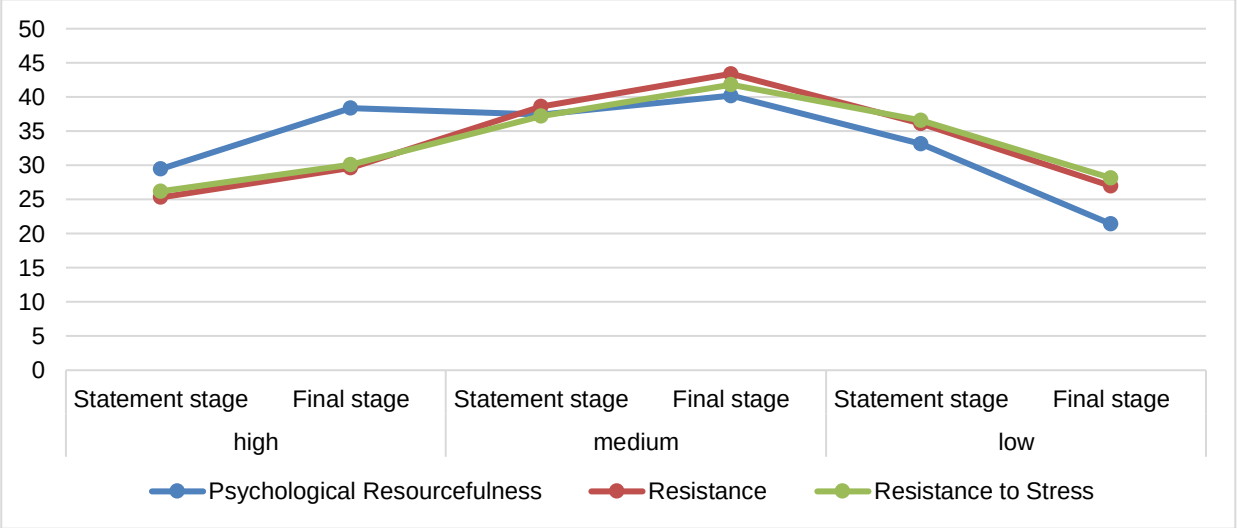

Figure 4. Comparative Analysis of Psychological Resilience Indicators among Engineering Students in the 1st-4th Years at the Initial and Final Stages of the Research, %
Source: Compiled by the authors based on the conducted research

From Figure 4, it is evident that at the final stage of the research, compared to the initial stage, there was an increase in all indicators of psychological resilience: psychological resourcefulness, resilience, and stress resistance. At the final stage, there was a recorded increase in the number of respondents with high psychological resourcefulness (by 8.9%) and with average levels (by 2.8%). Additionally, an increase was noted in the number of respondents with high resilience (by 4.3%) and average levels of this parameter (by 5.8%). The number of respondents with high stress resistance increased by 4.9% at the final stage compared to the initial stage, while those with average levels increased by 5.6%. At the same time, there was a proportional decrease in the number of subjects with low indicators across all analyzed parameters of psychological resilience. This indicates the effectiveness of the proposed developmental-corrective program.

Discussion

In the scholarly works related to our research, the importance of forming psychological resilience in students under stress is emphasized (Dekusar & Davidova, 2024; Moskalenets & Fedyk, 2024). It is also noted that students are particularly susceptible to stress situations, which negatively impacts their overall mental health (Zhang et al., 2022). The authors of empirical studies confirm the positive influence of various activities on the development of psychological resilience among students, including physical, creative, spiritual, and social practices (Al-Rousan et al., 2023; Pasinringi et al., 2022). Similar studies highlight the importance of utilizing personal psychological resources to foster resilience and increase stress resistance (Babakhova et al., 2023). In the context of our research, the approach concerning the use of group work forms, particularly psychotherapeutic sessions, deserves attention (Yena, 2024). We also share the opinion of other researchers regarding the appropriateness of using creative exercises, relaxation, meditation, reframing, and daily routines as methods for developing students' psychological resilience.

Our research stands out for its comprehensive approach to assessing the main correlates of psychological resilience: psychological resourcefulness, resilience, and stress resistance. It is precisely the psychological resource of a person that enables them to form an adequate response to stressful situations. Resilience helps maintain the stability of students' psycho-emotional state under stress and their normal level of productivity. Stress resistance equips students with the ability to counteract stressors and resist their influence. This is particularly important in conditions of chronic stress and prolonged trauma that Ukrainian students are currently experiencing (Kostryba & Lyashko, 2023).

Summarizing the results of our research, we can fully agree with other researchers regarding the priorities for developing psychological resilience in students under stress. However, unlike the studies we described, recent scientific explorations highlight the COVID-19 pandemic as a primary stress condition for students (Barbayannis et al., 2022; Fang et al., 2022). The main challenge and provoking factor during this period was the social isolation of students and the shift from face-to-face communication to virtual formats. However, the challenges faced by Ukrainian students during wartime encompass not only social distancing but also constant existential threats, experiences of psychological trauma, loss, and grief, as well as the disruption of their usual way of life. These represent significantly more complex challenges in terms of developing and maintaining psychological resilience under stress. Therefore, the primary advantage of our research is its consideration of the stress factors of wartime in the diagnostic and developmental-corrective work concerning the enhancement of students' psychological resilience.

Our research is significant due to the potential to address the existing issues within psychological communities in higher education institutions regarding the formation of students' psychological resilience under stressful conditions. The research aligns with the stated goal, as suitable methods for developing psychological resilience in students under stress have been identified and tested. These methods can be utilized by practical psychologists working with students exhibiting low levels of psychological resilience.

Limitations

The main limitations of the research pertain to its execution among students in technical specialties at the Department of Philosophy and Pedagogy of Professional Training at the Faculty of Transport Systems of Kharkiv National Automobile and Highway University. Although the issue of developing psychological resilience in students is relevant to the entire system of higher education institutions in Ukraine.

Recommendations

The primary recommendations include expanding the research sample by including students from various fields of study across diverse higher education institutions in Ukraine.

Conclusions

The study covers the relevant topic of developing psychological resilience among students in stressful conditions. The conducted empirical research established a predominance of respondents among technical students with an average level of psychological resourcefulness and low levels of resilience and stress resistance. The lowest indicators were demonstrated by younger students, while the highest were shown by older students. Specifically, 29.5% of respondents exhibited high levels, 37.4% medium levels, and 33.1% low levels of psychological resourcefulness. Additionally, an average of 25.3% of students displayed high levels, 38.6% medium levels, and 36.1% low levels of personal resilience. Moreover, 26.2% of students exhibited high levels, 37.3% medium levels, and 36.6% low levels of stress resistance.

To foster psychological resilience among students in technical specialties, a developmental-corrective program has been proposed. The program incorporates cognitive, stimulating, activity-based, reflective, and prospective components. Within the program, methods for developing students' psychological resilience are suggested, including psychological, breathing, relaxation, art therapy, creative exercises, humor, "havening," reframing, mindfulness, web services, spiritual practices, and motivational videos. The program includes group discussions, sports-relaxation competitions, and psychological training sessions. The follow-up psychological reassessment conducted after the experimental implementation of the developmental-corrective program confirmed the growth of all psychological resilience indicators among students. There was an increase in the number of students with high (by 8.9%) and medium (by 2.8%) levels of psychological resourcefulness. The number of students exhibiting high (by 4.3%) and medium (by 5.8%) levels of personal resilience also increased, as did those with high (by 4.9%) and medium (by 5.6%) levels of stress resistance.

This attests to the effectiveness of our proposed approach to the psychological support of developing psychological resilience among students in technical fields under stress. It also confirms the hypothesis that using well-selected methods of psychological support contributes to enhancing students' psychological resilience in stressful conditions. The results of the study can be utilized in the psychological support systems for developing the psychological resilience of students in higher education institutions in Ukraine amidst stress-related challenges. Future research could focus on developing recommendations for enhancing psychological resilience among students from various disciplines under stress.

Bibliographic references

Al-Rousan, A. H., Ayasrah, M. N., & Khasawneh, M. A. S. (2023). Psychological stability and its relationship to academic performance among secondary school students. *Journal of Information Sciences Letters*, *12*(3), 1469-1478. https://www.naturalspublishing.com/files/published/m82768n518oyi9.pdf

Babakhova, L. G., Khachaturyan, N. N., & Lomova, N. V. (2023). Psychological well-being of students in digital educational environment. *E3S Web of Conferences, 389*, 08014. https://doi.org/10.1051/e3sconf/202338908014

Barbayannis, G., Bandari, M., Zheng, X., Baquerizo, H., Pecor, K., & Ming, X. (2022). Academic stress and mental well-being in college students: Correlations, affected groups, and COVID-19. *Frontiers in Psychology,* 13, 1-10. https://doi.org/10.3389/fpsyg.2022.886344

Byshevets, N., Andrieieva, O., Pasichniak, L., Goncharova, N., Yarmak, O., Zakharina, I., & Blystiv, T. (2024). Evaluation of emotional disorder risk in students with low physical activity levels under stressful conditions. *Journal of Physical Education and Sport*, *24*(4), 894-904. https://doi.org/10.7752/jpes.2024.04102

Dekusar, H., & Davidova, N. (2024). Aspects of students' psychological resistance forming when getting higher education in wartime. *Scientific Innovations and Advanced Technologies, 3*(31), 811-821. http://perspectives.pp.ua/index.php/nauka/article/download/9801/9854

Fan, J., Huang, Y., Yang, F., Cheng, Y., & Yu, J. (2024) Psychological health status of Chinese university students: Based on Psychological Resilience Dynamic System Model. *Frontiers in Public Health*, *12*, 1382217. https://doi.org/10.3389/fpubh.2024.1382217

Fang, Y., Ji, B., Liu, Y., Zhang, J., Liu, Q., Ge, Y., & Liu, C. (2022). The prevalence of psychological stress in student populations during the COVID-19 epidemic: A systematic review and meta-analysis. *Scientific Reports*, *12*(1), 12118. https://doi.org/10.1038/s41598-022-16328-7

Feng, N., Zhang, H., Cao, L., & Wang, X. (2024). Stress prediction based on chaos theory and an event–behavior–stress triangle model. *IEEE Transactions on Computational Social Systems.* https://doi.org/10.1109/TCSS.2024.3386752

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, *11*(2), 213–218. https://doi.org/10.1016/0022-3999(67)90010-4

Igar, T. M. (2024). Mental health stability and stress management of teachers. *Nexus International Journal of Science and Education*, *1*(1), 11184395. http://nijse.org/index.php/home/article/download/12/12

Kee-Jiar, Y., & Chia-Keat, Y. (2020). Helping undergraduate students cope with stress: The role of psychosocial resources as resilience factors, *The Social Science Journal, 60*(1), 120-142. https://doi.org/10.1080/03623319.2020.1728501

Klochkov, V. (2022). Psychological factors of personality resilience: scientific views. *Bulletin of the National University of Defense of Ukraine*, *5*(69), 58-66. http://visnyk.nuou.org.ua/article/download/262865/261424

Kostryba, N., & Lyashko, L. (2023). Personal characteristics of psychological resilience among youth in wartime conditions. *Psychological Prospects Journal*, *42*, 82–96. https://doi.org/10.29038/2227-1376-2023-42-kos

Kristensen, S. M., Larsen, T. M. B., Urke, H. B., & Danielsen, A. G. (2023). Academic stress, academic self-efficacy, and psychological distress: A moderated mediation of within-person effects. *Journal of Youth and Adolescence*, *52*(7), 1512-1529. https://doi.org/10.1007/s10964-023-01770-1

Kundii, Z., Skrypnikov, A., Isakov, R., Kutsenko, N., Zinchenko, N., & Vasylyeva, G. (2024). Coping with War Stress in Ukrainian Students. in Shchokin, R., Iatsyshyn, A., Kovach, V., Zaporozhets, A. (Eds.)

Digital Technologies in Education: Selected Cases (pp. 111-125). Cham: Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-57422-1_9

Limone, P., & Toto, G. A. (2022). Factors that predispose undergraduates to mental issues: A cumulative literature review for future research perspectives. *Frontiers in Public Health*, *10*, 831349. https://doi.org/10.3389/fpubh.2022.831349

Litwic-Kaminska, K., Błachnio, A., Kapsa, I., Brzezinski, Ł., Kopowski, J., Stojkovic, M., Hinic, D., Krsmanovic, I., Ragni, B., Sulla, F., & Limone, P. (2023). Resilience, positivity and social support as perceived stress predictors among university students. *International Journal of Environmental Research and Public Health, 20*, 6892. https://doi.org/10.3390/ijerph20196892

Liu, X., Zhu, C., Dong, Z., & Luo, Y. (2024). The relationship between stress and academic self-efficacy among students at elite colleges: A longitudinal analysis. *Behavioral Sciences, 14*, 537. https://doi.org/10.3390/bs14070537

Makhubela, M. (2022). Assessing psychological stress in South African university students: Measurement validity of the perceived stress scale (PSS-10) in diverse populations. *Current Psychology*, *41*(5), 2802-2809. https://link.springer.com/article/10.1007/s12144-020-00784-3

Moskalenets, V. P., & Fedyk, O. V. (2024). Psychological resilience of students in the conditions of the criminal war of Russia against Ukraine. *Slobozhansky Scientific Bulletin. Series: Psychology*, *1*, 116-125. https://doi.org/10.32782/psyspu/2024.1.21

Mykhaylyshyn, U. B., Stadnik, A. V., Melnyk, Y. B., Vveinhardt, J., Oliveira, M. S., & Pypenko, I. S. (2024). Psychological stress among university students in wartime: A longitudinal study. *International journal of science annals.*, *7*(1), 27-40. Retrived from https://dspace.uzhnu.edu.ua/jspui/bitstream/lib/63300/1/ijsa.2024.1.6.pdf

Pasinringi, M. A. A., Vanessa, A. A., & Sandy, G. (2022). The relationship between social support and mental health degrees in emerging adulthood of students. *Golden Ratio of Social Science and Education*, *2*(1), 12-23. https://doi.org/10.52970/grsse.v2i1.162

Rebryk, O. (2024). *A lot of international students remained in Ukraine during the war and actively help*. Hromadske.radio. Retrived from https://acortar.link/Whcciu

Sarbassova, G., Kudaibergenova, A., Madaliyeva, Z., Kassen, G., Sadvakassova, Z., Ramazanova, S., & Ryskulova, M. (2024). Diagnostics of psychological flexibility and the ability to cope with the inevitable changes among psychology students. *Current Psychology*, *43*(6), 5364-5376. https://doi.org/10.1007/s12144-023-04712-z

Schwartz, S. J., Cobb, C. L., Meca, A., Bautista, T., Sahbaz, S., Alpysbekova, A., & Szapocznik, J. (2024). Cultural stress, personal identity development, and mental health among US Hispanic college students. *American Journal of Orthopsychiatry*. Retrived from https://acortar.link/0CBsHL

Sharov, O. (2022). *The impact of war on higher education in Ukraine: Challenges and prospects*. Cedos. Retrived from https://cedos.org.ua/events/vplyv-vijny-na-vyshhu-osvitu-v-ukrayiny-vyklyky-ta-perspektyvy/

Shkolina, N.V., Shapoval, I.I., Orlova, I.V., Kedyk, I.O., & Stanislavchuk, M.A. (2020). Adaptation and validation of the ukrainian version of the Connor — Davidson Resilence Scale-10 (CD-RISC-10): Approbation in patients with ankylosing spondyliti. *Ukrainian Rheumatology Journal*, *2*(80), 66-72. Retrived from https://www.rheumatology.kiev.ua/wp/wp-content/uploads/2020/07/1187.pdf

Shtepa, O. S. (2018). The questionnaire of a personality's psychological resourcefulness: the results of development and approbation of the author's method. in Maksymenko, S. D., Onufriieva, L. A. (Eds.) *Problems of Modern Psychology: Collection of research papers of Kamianets-Podilskyi National Ivan Ohiienko University*, 39, (pp. 380–399). Kamianets-Podilski: Axiom. https://acortar.link/DJg28L

Slimmen, S., Timmermans, O., Mikolajczak-Degrauwe, K., & Oenema A. (2022). How stress-related factors affect mental wellbeing of university students. A cross-sectional study to explore the associations between stressors, perceived stress, and mental wellbeing. *PLoS ONE, 17*(11), 0275925. https://doi.org/10.1371/journal.pone.0275925

Spytska, L. (2024). Psychological stability of the individual in extreme situations. *European Journal of Trauma & Dissociation*, *8*(4), 100467. https://doi.org/10.1016/j.ejtd.2024.100467

Theron, L., Ungar, M., & Höltge, J. (2022). Pathways of resilience: Predicting school engagement trajectories for South African adolescents living in a stressed environment. *Contemporary Educational Psychology*, *69*, 102062. https://doi.org/10.1016/j.cedpsych.2022.102062

Wang, H., Jia, R., Zhang, M., & Fan, W. (2024). The influence of stress on mental health among Chinese college students: The moderating role of psychological suzhi. *Heliyon*, *10*(5), 26699. https://www.cell.com/heliyon/fulltext/S2405-8440(24)02730-0

Yena, A. (2024). Psychological resources of personality as a factor in overcoming stress. *Society and National Interests, 4*(4), 313-324. https://doi.org/10.52058/3041-1572-2024-4(4)-313-324

Yunusovich, A. V., Ahmedov, F., Norboyev, K., & Zakirov, F. (2022). Analysis of experimental research results focused on improving student psychological health. *International Journal of Modern Education and Computer Science*, *15*(2), 14. https://doi.org/10.5815/ijmecs.2022.02.02

Zhang, Z., Wang, T., Kuang, J., Herold, F., Ludyga, S., Li, J., ... & Zou, L. (2022). The roles of exercise tolerance and resilience in the effect of physical activity on emotional states among college students. *International journal of clinical and health psychology*, *22*(3), 100312. https://doi.org/10.1016/j.ijchp.2022.100312

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.15
Cómo citar:
Avendaño-López, P.D.U., González Torres, A., & Figueroa-Anzures, C. (2024). El impacto del aprendizaje basado en aplicaciones móviles y IA en la comprensión de variables aleatorias discretas. *Revista Eduweb*, *18*(4), 219-240. https://doi.org/10.46502/issn.1856-7576/2024.18.04.15

El impacto del aprendizaje basado en aplicaciones móviles y IA en la comprensión de variables aleatorias discretas

The impact of mobile app-based learning and AI on understanding discrete random variables

Avendaño-López Pavel David Ulises
https://orcid.org/0000-0003-1536-1784
pavel.al@milpaalta.tecnm.mx
Tecnológico Nacional de México/ Instituto Tecnológico de Milpa Alta, Docente, Ciudad de México, México.
González Torres Arturo
https://orcid.org/0000-0002-3337-7600
cann.azteca13@gmail.com
Tecnológico Nacional de México/ Instituto Tecnológico de Milpa Alta, Profesor - Investigador, Ciudad de México, México.
Autor corresponsal
Figueroa-Anzures Cynthia
https://orcid.org/0009-0009-4627-2865
cynthia.figueroa@bachilleres.edu.mx
Colegio de Bachilleres/Plantel 13 “Quirino Mendoza y Cortés”, Docente, Ciudad de México, México.

Recibido: 24/10/24
Aceptado: 19/12/24

Resumen

Este estudio analiza la enseñanza de variables aleatorias discretas utilizando la app móvil “PROBABILITY DISTRIBUTIONS” y respuestas generadas por la Inteligencia Artificial de MetaIA. Participaron 95 alumnos del CETIS 167, quienes cursan el sexto semestre en probabilidad y estadística. Se inició con la explicación de la distribución de Bernoulli para comprender eventos dicotómicos. Posteriormente, los estudiantes emplearon la app para calcular probabilidades con esta distribución y explorar conceptos relacionados con reemplazo y sin reemplazo, conectados a las distribuciones hipergeométrica y de Bernoulli, respectivamente. Además, se abordó la distribución de Poisson como proceso estocástico, empleando la app para modelar funciones de masa de probabilidad. En la etapa final, los alumnos resolvieron una evaluación de cuatro reactivos, utilizando tanto la app como MetaIA. Los resultados indicaron que los estudiantes lograron una mejor interpretación de los problemas al centrarse en el análisis conceptual más que en cálculos manuales. MetaIA mostró fortalezas en clasificar y desglosar ejercicios según distribuciones, aunque presentó errores en cálculos matemáticos debido a la falta de precisión en la integración de fuentes. Se concluye que la combinación de Tecnologías del Aprendizaje y Conocimiento con Inteligencia Artificial puede facilitar la resolución de problemas reales y promover una comprensión más profunda en los estudiantes.

Palabras clave: Variables Aleatorias Discretas, Probability Distribution, MetaIA, probabilidad, distribución Bernoulli, distribución Binomial, distribución hipergeométrica, distribución Poisson, Inteligencia Artificial.

Abstract

This study analyzes the teaching of discrete random variables using the mobile app “PROBABILITY DISTRIBUTIONS” and responses generated by MetaIA Artificial Intelligence. 95 students from CETIS 167, who are in the sixth semester of probability and statistics, participated. It began with the explanation of the Bernoulli distribution to understand dichotomous events. Later, the students used the app to calculate probabilities with this distribution and explore concepts related to replacement and without replacement, connected to the hypergeometric and Bernoulli distributions, respectively. In addition, the Poisson distribution was addressed as a stochastic process, using the app to model probability mass functions. In the final stage, the students solved a four-item evaluation, using both the app and MetaIA. The results indicated that the students achieved a better interpretation of the problems by focusing on conceptual analysis rather than manual calculations. MetaIA showed strengths in classifying and breaking down exercises according to distributions, although it presented errors in mathematical calculations due to the lack of precision in the integration of sources. It is concluded that the combination of Learning and Knowledge Technologies with Artificial Intelligence can facilitate the resolution of real problems and promote a deeper understanding in students.

Keywords: Discrete Random Variables, Probability Distribution, MetaIA, probability, Bernoulli distribution, Binomial distribution, hypergeometric distribution, Poisson distribution, Artificial Intelligence.

Introducción

En la era de la digitalización y el auge de las nuevas tecnologías, el uso de herramientas tecnológicas en la educación ha crecido exponencialmente. A nivel internacional, la inteligencia artificial (IA) se ha posicionado como un recurso fundamental en diversos campos, incluido el educativo. Países como Estados Unidos y Singapur han implementado IA en la enseñanza de matemáticas y ciencias, observando mejoras significativas en la personalización del aprendizaje y el análisis de datos. Este contexto ha fomentado la creación de diversas plataformas y aplicaciones destinadas a optimizar el proceso de enseñanza-aprendizaje en áreas complejas como la estadística y probabilidad, integrando simulaciones y cálculos automáticos que permiten una mayor comprensión de conceptos abstractos como las variables aleatorias discretas.

En México, la enseñanza de la estadística y probabilidad ha cobrado relevancia en los últimos años debido a la creciente demanda de competencias cuantitativas en distintos campos profesionales. A nivel nacional, los currículos educativos de nivel medio superior y universitario han comenzado a integrar tecnologías de aprendizaje que faciliten la adquisición de habilidades estadísticas, esenciales en disciplinas como las ciencias físico-matemáticas, ciencias sociales y administrativas, y las ciencias médico-biológicas.

El objetivo principal de este estudio es comparar la efectividad de la enseñanza de variables aleatorias discretas mediante el uso de una aplicación móvil llamada "Probability Distributions" en contraposición a las respuestas generadas por una inteligencia artificial (Meta IA). Este análisis se lleva a cabo en un grupo de estudiantes del nivel medio superior con el fin de evaluar cuál de las dos herramientas proporciona una mejor comprensión de los conceptos estadísticos y sus aplicaciones.

La justificación del estudio radica en la necesidad de utilizar tecnologías emergentes para mejorar la enseñanza de temas complejos como las distribuciones de probabilidad, donde tradicionalmente los alumnos suelen enfrentar dificultades debido a la naturaleza abstracta de los conceptos. Además, el uso de herramientas tecnológicas puede promover un aprendizaje más interactivo y significativo, mejorando la retención y comprensión del contenido.

No obstante, este estudio presenta limitantes importantes. En primer lugar, la dependencia de recursos tecnológicos como los dispositivos móviles y el acceso a internet puede afectar la implementación de las aplicaciones en zonas rurales o de bajos recursos, donde los estudiantes no siempre cuentan con las herramientas necesarias. Asimismo, la comparación entre la aplicación y la IA se limita a una evaluación cualitativa, por lo que no se abordan con profundidad los aspectos cuantitativos de cada enfoque en

términos de resultados a largo plazo.

La presente investigación se articula mediante una estructura pentagonal que permite abordar de manera sistemática y rigurosa la intersección entre las tecnologías emergentes y la didáctica de la estadística. El corpus inicial desarrolla un exhaustivo marco conceptual que examina las convergencias entre los dispositivos móviles y los sistemas de inteligencia artificial en el contexto pedagógico de la estadística, con especial énfasis en las investigaciones contemporáneas sobre la enseñanza de variables aleatorias discretas. El segundo componente pormenoriza el aparato metodológico implementado, estableciendo los criterios de selección muestral, la arquitectura investigativa y el instrumental analítico empleado para la recolección y procesamiento de datos. La tercera sección presenta un análisis comparativo entre la efectividad pedagógica de las aplicaciones móviles y los sistemas de inteligencia artificial, sustentado en evidencia empírica. El cuarto segmento desarrolla una exégesis de los hallazgos obtenidos, contextualizada en el marco del acervo científico existente, estableciendo diálogos con investigaciones precedentes y delineando nuevas perspectivas interpretativas. La investigación culmina con un apartado dedicado a las inferencias derivadas del estudio, sus repercusiones en el ámbito de la praxis educativa y la formulación de directrices para futuras líneas de investigación en este campo.

Referentes teóricos o revisión de literatura

La implementación de Tecnologías o simuladores en el aula ha experimentado una amplia adopción, y de esta manera también ha generado cambios en los métodos de enseñanza y aprendizaje. Al igual que en el estudio de Álvarez Álvarez, & Jiménez Ruiz (2022), en su estudio investigo las iniciativas de educación móvil en varios países de Latinoamérica, se reconocieron 5 propuestas de Chile, 3 propuestas de Colombia, 3 propuestas de Argentina, 4 propuestas de México; y una propuesta de El Salvador, Paraguay, Honduras y Perú; todas estas se implementaron desde el 2003 hasta el 2020. Estas propuestas han facilitado la alfabetización digital de los alumnos, además de contribuir a reducir el rezago estudiantil por diferentes razones, al mismo tiempo que fomentan la motivación y la formación profesional (Álvarez Álvarez & Jiménez Ruiz, 2022).

El ChatGPT es un instrumento innovador para la enseñanza y el aprendizaje de matemáticas. En el estudio de Wardat et al. (2023), indica que llevó a cabo una investigación acerca del empleo de la herramienta, enfocándose principalmente en potenciar las capacidades matemáticas, solucionar problemas matemáticos y solucionar interrogantes de problemas geométricos. Se nota que el instrumento facilita la descomposición progresiva de los procedimientos para solucionar problemas algebraicos, integrales, derivadas y ecuaciones diferenciales. De igual manera, indica que presenta un error respecto a las cantidades mostradas, pero este inconveniente puede ser utilizado para que el estudiante desarrolle un pensamiento crítico y se aproveche a través de procedimientos. Se recomienda la utilización de preguntas concretas y una escritura sencilla, dado que pueden surgir dificultades al explorar la conversación (Wardat et al., 2023).

Mediante una revisión sobre la aplicación de la inteligencia artificial en los diversos procesos, Bolaño-García, & Duarte-Acosta (2024), determina el promedio de producción científica anual, así como los países con una mayor cantidad de publicaciones de estos. Dentro de las naciones con más publicaciones se encuentran Estados Unidos, China, Reino Unido, entre otras. Se reconocen los aspectos de ventajas y retos para la implementación de la IA, asi tambien los elementos clave de éxito, y se proponen nuevas oportunidades y posibilidades que brinda la IA en el ámbito educativo. Además, señala que es necesario ser cauteloso y estratégico, para garantizar la transparencia, la ética y la cooperación entre todos los participantes, tanto directa como indirectamente, en la educación (Bolaño-García & Duarte-Acosta, 2024).

Además, hay una variación considerable entre las versiones que se empleen de ChatGPT. Por ejemplo, en la investigación de Korkmaz Guler et al. (2024), llevó a cabo la comparación de resolución de las versiones 3.5 y 4.0 de ChatGPT, empleando un examen estandarizado de matemáticas en Turquía. Por lo general, ambas versiones recibieron respuestas instantáneas, otros ejercicios los solucionó de manera equivocada, y otros más no los solucionó ni en un primer ni en un segundo intento. No obstante, la versión

4.0 obtuvo una calificación superior. Es útil brindarle un feedback al mismo chat, para que pueda modificar y solucionar un ejercicio (Korkmaz Guler et al., 2024).

Aho-Meri (2024) llevó a cabo un estudio sobre proporcionar instrucciones de 25 temas estadísticos, de los cuales 19 se referían a conceptos estadísticos y 6 a temas avanzados de estadística. Proporcionando el mismo estímulo a inteligencias artificiales como ChatGPT y Gemini, pidió a los estudiantes que seleccionaran cual se ajusta más al concepto necesario. En el análisis de los datos, los factores que seleccionan a las Inteligencia Artificial son el valor -p, la regresión lineal, el test-t, la distribución de Cauchy, la dependencia no-linear, las derivadas y los eigenvalores. Los temas que el docente y el estudiante donde eligen de manera conjunta, a utilizar ChatGPT y Gemini son: distribución normal, coeficiente de correlación, análisis de datos funcional. Aunque los alumnos muestran una aceptación superior de las respuestas de ChatGPT para: variables aleatorias, desviación estándar, análisis de series temporales, inferencia estadística, curtosis. Los docentes suelen emplear ChatGPT para: procesos gaussianos, tendencia de series, varianza (Aho, 2024).

Pese a los múltiples beneficios que ofrece la creación de contenidos con Inteligencia Artificial como ChatGPT, también existen ciertas restricciones, tal como señala Lopezosa et al., (2024) en su estudio de España, en el que se examinaron 32 proyectos periodísticos que contaban con el respaldo de la inteligencia artificial. Es necesario establecer límites precisos en la utilización de la Inteligencia Artificial, como es escribir las demandas a cada tipo de escritura para prevenir la generación de ruido informativo. Así pues, es necesario establecer protocolos de comprobación de datos y una adecuada supervisión humana en los procesos de creación de contenido (Lopezosa et al., 2024).

En un estudio acerca de las herramientas TIC empleadas en el aula, se detecta un uso predominante en Geogebra. Según Cenich et al., (2020), selecciono a varios docentes de diferentes instituciones educativas y, mediante una entrevista, detecto la aplicación del Modelo TPACK. Este modelo fusiona tres elementos clave como son: el conocimiento del contenido de la asignatura, el saber pedagógico y el saber tecnológico. Se reconocen tres entrevistas que contemplan de manera directa la utilización de los tres componentes. Dado que posibilitan que el estudiante ejerza la manipulación libre para observar los elementos matemáticos comunes y los que varían considerablemente (Cenich et al., 2020).

En Colombia, Sarrazola (2023) señala que la utilización de chatbots como instrumentos adicionales en el aula presenta riesgos, complicaciones y ventajas. Se llevaron a cabo ejercicios de matemáticas complejas en ChatGPT 3.5, y se notó que los estudiantes pueden fomentar un razonamiento crítico, además de proporcionar una retroalimentación previa a las ideas matemáticas. Se sugiere un beneficio en el progreso del saber cuándo los docentes orienten dicho saber. Se recomienda emplear la versión ChatGPT 4 (Sarrazola, 2023).

De acuerdo con las experiencias compartidas por estudiantes y docentes originarios de México, Chile y Argentina, se llevaron a cabo prácticas en diversos temas de probabilidad y estadística, las cuales se integraron con datos de su propio entorno social y económico. El objetivo fue fomentar la intuición y el razonamiento en los procesos de manipulación de datos, tanto en estudiantes de secundaria como en los de nivel superior, así como en docentes que participaron en un curso de capacitación. Como resultado, se lograron mejoras en los rendimientos de los estudiantes, alcanzando incrementos en la efectividad de la enseñanza de los temas de probabilidad y estadística, que varian entre un 10 y 85 % (Mabel-Tauber et al., 2019).

En el estudio de Inzunza Cazares & Islas Anguiano (2019) llevado a cabo en la Universidad de Sonora, México; se sugieren cuatro actividades de estadística y el estudiante debe tener la habilidad de deducir acerca de los conceptos de población, muestreo e interpretación de estos. Por lo tanto, surge el problema con alternativas, y es posible categorizar las argumentaciones según un esquema jerárquico, los cuales se detallan a continuación. Preestructural, en la que el estudiante solo posee conceptos básicos sobre los principios estadísticos; Uniestructural, los estudiantes vinculan ciertas características de las distribuciones;

multiestructural, en la que el alumno relaciona diversas características de la distribución; y relacional, en la que el alumno entiende diversas características de las distribuciones. Principalmente, se notó que los estudiantes no poseen un lenguaje estadístico formal (Inzunza Cazares & Islas Anguiano, 2019).

Estamos en un mundo complejo e incierto, en el cual día a día se incrementa la información en cualquiera de los sectores productivos. Por lo tanto, es prioridad la incorporación del estudio de la estadística y la probabilidad en los salones de clase, con el propósito de ayudar a los estudiantes en la adquisición del sentido estadístico. Es decir, unificar la cultura estadística, el pensamiento y el razonamiento estadístico (Batanero et al, 2013).

Se considera que en México la educación estadística está siendo cada vez más reconocida por su importancia en la educación de cualquier ciudadano, su inclusión en las diferentes carreras universitarias y su aportación para generar conocimiento nacional (económico, social, político, educativo y de salud) (Gómez Blancarte et al., 2022; Gal, 2007). Los siguientes elementos se consideran como las características que deben tener los estudiantes para poder aprender y aplicar la materia de probabilidad y estadística en el nivel bachillerato. Ver tabla 1.

Tabla 1.
Competencias previas del alumno.

Cultura estadística	
Habilidades de alfabetización estadística	Comprender e interpretar la información estadística en forma de prosa, así como también en forma de gráficas, diagramas y tablas.
Conocimiento estadístico base	Se trata de un conocimiento que ayuda a comprender la información estadística.
Conocimiento matemático	Permite comprender y analizar datos.
Conocimiento del contexto	Desarrolla una postura crítica ante los mensajes estadísticos
Preguntas criticas (postura crítica; creencias y actitudes)	Es necesaria para cuestionar los resultados o conclusiones generadas a partir del dato estadístico. Esto supone que se debe asumir una apreciación del poder de los procesos estadísticos y aceptar que los estudios propiamente planificados tienen el potencial para llevar a conclusiones más válidas que solo basarse en experiencias anecdóticas o personales.

Los currículos actuales para la educación estadística en las universidades demandan el desarrollo de habilidades de problemas mediante el uso de datos reales que permitan darle sentido al mundo que rodea a los estudiantes, lo cual requiere conocer el proceso de análisis de datos, así como promover un razonamiento y el pensamiento estadísticos. (Horton & Hardin, 2015)

La Estadística por su parte se ha convertido en las últimas décadas, en una ciencia importante, principalmente por tres razones: a) es una herramienta utilizada por muchas disciplinas, ciencias y profesiones para el desarrollo particular de sus investigaciones; b) la competitividad en el sector productivo ha generado una preocupación por darle un tratamiento estadístico a problemas de productividad y calidad en las organizaciones, aspecto que Deming (el padre del desarrollo industrial Japonés) destacó en los siguientes términos: “Ningún recurso es tan escaso como el conocimiento estadístico. No hay conocimiento que pueda contribuir tanto a mejorar la calidad, productividad y competitividad de las empresas como el de los métodos estadísticos”. (Romero Villafranca & Zunica Ramajo, 2013).

La sociedad moderna se encuentra rodeada de datos que proceden de diferentes fuentes y cuyo tratamiento implica que cada persona en su cotidianidad tenga que leer, interpretar, criticar y apropiarse de información, para lo cual se requieren algunas habilidades (alfabetización estadística). (Zapata Cardona, 2011).

Técnicas estadísticas utilizadas por ramas profesionales.

De acuerdo con el perfil profesional que el alumno de nivel bachillerato elija, se consideran los temas selectos de probabilidad y estadística a utilizar. Para las áreas de las ciencias fisicomatemáticas (FM), sociales-administrativas (SA), y médico-biológicas (MB), se consideran los temas de estadística descriptiva, inferencia estadística, regresión y correlación, análisis de series temporales, pronósticos, procesos estocásticos, análisis multivariado, análisis de supervivencia, métodos no paramétricos y resampling, métodos computacionales y simulación. Cada una de ellas tiene su propia particularidad de acuerdo con el evento aplicado. (Atlman, 1990; Rosner, 2006; Pagano & Gauvreau, 2018; Kleinbaum, & Klein, 2012; Agresti, 2018; Agresti, 2021; Moore et al., 2017; Field, 2013; Gujarati & Porter, 2009; Wooldridge, 2020; Babbie, 2021; Grimmett & Stirzaker, 2020; Ross, 2019; Durrett, 2019; Rice, 2006; Casella & Berger, 2002; DeGrooot & Schervish, 2002).

Destacando la importancia de las Variables Aleatorias Discretas (VAD), se presenta que para las ciencias físico-matemáticas, se modelan los fenómenos físicos que involucran conteos, como numero de partículas especificas en un experimento, número de piezas defectuosas en los procesos industriales. En las ciencias sociales y administrativas, las VAD son aplicadas en modelación y análisis de datos de encuestas, estudios de mercado, número de clientes para un evento favorable. Y para las ciencias médico-biológicas son de suma importancia porque permiten modelar los eventos biológicos, la detención de células específicas, infecciones en pacientes, o mutaciones presentadas en los experimentos. (Devore, 2016; Montgomery & Runger, 2018; Wasserman, 2004; Moore et al., 2017; Atlman, 1990; Agresti, 2021) En la tabla 2, se resalta los temas específicos por área.

Tabla 2.
Importancia de las VAD en las ciencias.

	FM	SA	MB
Distribución de probabilidad	binomial Poisson normal exponencial gamma	binomial normal Poisson	binomial normal Poisson distribución de Weibull
Variables Aleatorias Discretas	modelan fenómenos físicos como conteo de elementos o piezas	modelan eventos como encuestas y estudios de mercado	modelan eventos como conteo de células o sucesos biológicos
Procesos Estocásticos	cadenas de Markov, procesos de Poisson, movimiento browniano	cadenas de Markov, procesos de decisión	procesos de Poisson, modelos de Markov

Cuando es necesario considerar la probabilidad del éxito y el fracaso de un solo evento, esto se define como la distribución de Bernoulli. Si aumenta el número de casos a mayor a un evento, se pueden tener dos posibilidades. Uno donde se tendrá un evento de reemplazo, donde al elegir el objeto ya no se regresa a la condición original y se calcula la distribución Hipergeométrica. Mientras que, si el objeto elegido se devuelve a la población original, se considera con reemplazo, se considera distribución binomial. Esto se muestra en la siguiente grafica.

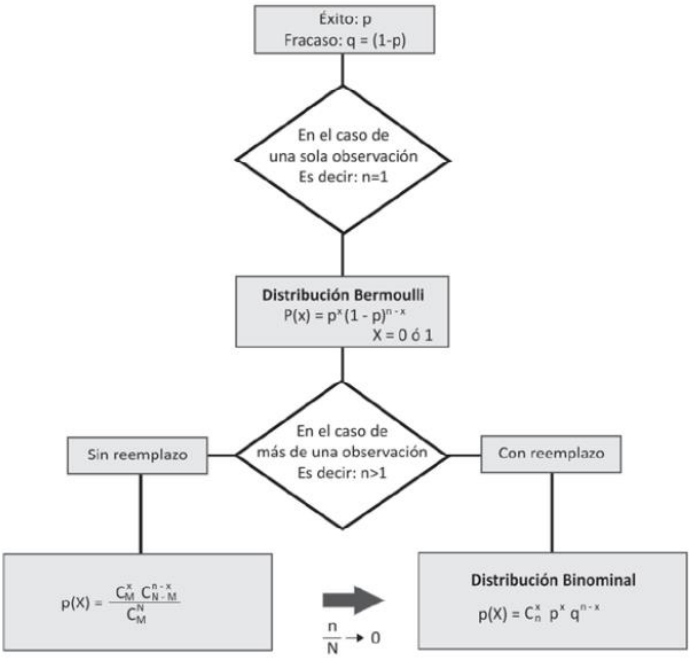

Figura 1. Grafica de la aplicación de fenómenos dicotómicos.
(Guadarrama Bustos & Aguilar Lopez, 2021).

Por otro lado, la distribución de Poisson se utiliza para sucesos raros y aleatorios. Y dependiendo de los datos y las probabilidades de éxito, puede actuar como límite de la distribución binomial o como un proceso estocástico. Ver la figura 2.

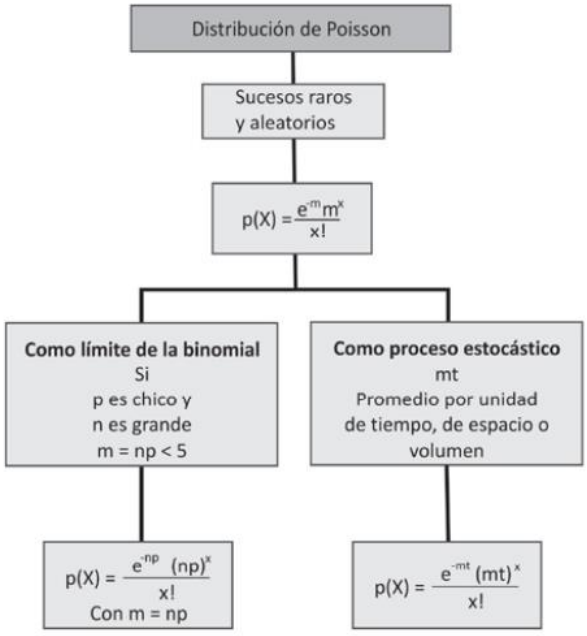

Figura 2. Grafica de las aplicaciones de la Distribución de Poisson.
(Guadarrama Bustos & Aguilar Lopez, 2021).

El progreso de las tecnologías móviles y de inteligencia artificial (IA) ha revolucionado los modelos convencionales de enseñanza y aprendizaje, particularmente en campos que requieren de destrezas matemáticas y analíticas, como la probabilidad y la estadística. Específicamente, las variables aleatorias discretas son un asunto crucial en la evolución del pensamiento estadístico, ya que posibilitan a los alumnos entender fenómenos aleatorios y modelar situaciones prácticas de incertidumbre. Sin embargo, su instrucción frecuentemente se topa con obstáculos vinculados con la abstracción del concepto y la ausencia de recursos pedagógicos que simplifiquen su entendimiento. Las aplicaciones para dispositivos móviles y las plataformas basadas en Inteligencia Artificial, como Meta AI, proporcionan una perspectiva innovadora y enérgica para enfrentar estos retos, posibilitando un aprendizaje más interactivo y ajustado a las demandas individuales.

Aunque hay estudios anteriores que apoyan la utilización de estas tecnologías en la educación, existe una escasa comparación entre su eficacia en el aprendizaje de temas particulares, como las variables aleatorias discretas. Por una parte, las aplicaciones móviles educativas proporcionan un ambiente organizado que orienta a los alumnos mediante actividades prácticas diseñadas para potenciar sus capacidades y saberes. En contraposición, las herramientas de Inteligencia Artificial como Meta AI garantizan un aprendizaje más adaptable y personalizado, ajustándose al nivel de entendimiento y velocidad de cada usuario. En este escenario, se presenta la necesidad de determinar de manera empírica cuál de estas herramientas es más eficaz para el aprendizaje de conceptos estadísticos fundamentales en el nivel de bachillerato, especialmente en centros educativos de la Ciudad de México.

En consecuencia, este estudio propone un diseño experimental que contrasta el efecto de una aplicación móvil educativa con Meta AI en el aprendizaje de las variables aleatorias discretas. Las siguientes secciones detallan el método empleado, que abarca la elección de los participantes, los instrumentos de evaluación y los procesos de ejecución y análisis.

Metodología

Método

Se utilizó un enfoque cuantitativo, ya que el estudio se centró en la comparación de resultados numéricos obtenidos de dos herramientas: una aplicación móvil y una inteligencia artificial, para analizar el aprendizaje de variables aleatorias discretas.

Nivel de Investigación

El nivel de investigación es descriptivo y exploratorio

Es descriptivo porque el estudio se enfoca en observar, registrar y analizar cómo los estudiantes comprenden las variables aleatorias discretas a través del uso de dos herramientas: una aplicación móvil y una inteligencia artificial. Se documentan los resultados obtenidos por los alumnos y la IA, proporcionando una descripción detallada de las respuestas y su precisión, lo que permite identificar patrones de aprendizaje y comprensión.

Por otro lado, es exploratorio porque se busca indagar en un tema relativamente nuevo en el contexto educativo, que es la comparación entre tecnologías de aprendizaje (como la aplicación móvil) y la inteligencia artificial en la enseñanza de conceptos estadísticos. El estudio no se limita a describir, sino que también explora cómo estas herramientas pueden ser implementadas y qué impacto tienen en el proceso de aprendizaje, lo que abre la puerta a investigaciones futuras más profundas y cuantitativas en este campo.

Procedimiento

Selección de la muestra: Se seleccionaron 95 estudiantes del sexto semestre de la materia de probabilidad y estadística en el CETIS 167, turno vespertino.

Fases de enseñanza:

- Fase 1: Se presentó la distribución de Bernoulli, y los estudiantes trabajaron con la aplicación móvil para resolver problemas sobre eventos dicotómicos.
- Fase 2: Se explicaron las distribuciones binomial, hipergeométrica y de Poisson, utilizando ejemplos y la aplicación para determinar las probabilidades.
- Comparación de herramientas: Los ejercicios también fueron ingresados en la IA para comparar los resultados con los obtenidos por los estudiantes.
- Evaluación: Se proporcionó una evaluación de 4 reactivos a los estudiantes y a la IA para comparar las interpretaciones y errores en los resultados.

Participantes

La población estuvo constituida por 95 estudiantes del CETIS 167, de los cuales 46 eran hombres y 49 mujeres, todos cursando el sexto semestre de probabilidad y estadística.

Instrumento

Se utilizó la aplicación móvil "Probability Distributions" para enseñar a los estudiantes a manejar distribuciones estadísticas, y la inteligencia artificial MetaIA para la comparación de resultados en los ejercicios.

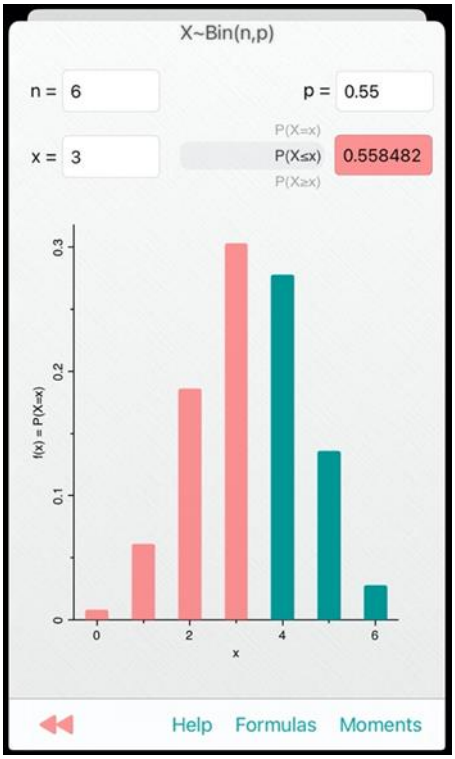

Figura 3. Ejemplo de figura o gráfica.

La secuencia de los temas dentro de la planificación de clases fue en el siguiente orden: Distribución aleatoria de Bernoulli, Distribución aleatoria Binomial, distribución aleatoria Hipergeométrica, y distribución

aleatoria de Poisson. En cada una de las etapas se les enseño la manipulación del software, la interpretación de los resultados, la importancia de las gráficas. En cada una de las distribuciones se proporcionaron ejercicios de contextos cotidianos, y con un lenguaje sencillo y sin tecnicismos.

Para concluir se les proporciono tres ejercicios en donde el alumno debía identificar qué tipo de distribución es, y como resolverla, para finalizar debía redactar una conclusión sobre el resultado obtenido, contemplando los valores como media, varianza y lo que observaba en la gráfica. Al mismo tiempo se realiza la resolución de los mismos ejercicios utilizando la inteligencia artificial de Meta IA.

Los ejercicios por evaluar fueron los siguientes:

Se seleccionará un jurado de 12 miembros para un caso penal de un grupo de 14 hombres y 11 mujeres. ¿Cuál es la probabilidad de que el jurado esté compuesto por 6 hombres y 6 mujeres? ¿Cuál es la probabilidad de que al menos 3 jurados sean mujeres? ¿Cuál es el número esperado de mujeres? Realiza la gráfica en la aplicación Probability Distribution, determina la esperanza matemática y la varianza. REDACTA UNA CONCLUSION DE 50 PALABRAS, DE ACUERDO CON EL CONTEXTO DEL PROBLEMA

Supongamos que los nacimientos de niños y niñas tienen la misma probabilidad y que el nacimiento de cualquier niño no afecta la probabilidad del género de los demás niños. Si se seleccionan 10 nacimientos. Determinar la probabilidad de que nazcan como máximo tres niños, existan como mínimo 7 varones, existan entre 4 y 6 varones, Realiza la gráfica en la aplicación Probability Distribution. Determina la esperanza matemática y la varianza. REDACTA UNA CONCLUSION DE 50 PALABRAS, DE ACUERDO CON EL CONTEXTO DEL PROBLEMA

Se analiza el agua de un lago y se descubre que contiene, en promedio, tres bacterias por litro de agua. Se toma una muestra de 250 ml del lago. Determine la probabilidad de que la muestra de agua de 250 ml contenga exactamente dos bacterias; al menos dos bacterias; ninguna bacteria. Realiza la gráfica en la aplicación Probability Distribution, Determina la esperanza matemática y la varianza. REDACTA UNA CONCLUSION DE 50 PALABRAS, DE ACUERDO CON EL CONTEXTO DEL PROBLEMA

Se realizó una lista de cotejo para identificar los procedimientos, las gráficas y la conclusión. La guía de observación se muestra en la tabla 3.

Tabla 3.
Guía de observación para las competencias procedimentales.

Criterio	Cumple
Comprensión de los conceptos de la distribución	
Precisión en los cálculos de probabilidades	
Habilidad para generar gráficos y visualizaciones correctas	
Claridad en la presentación de conclusiones	

La recolección de información se llevó a cabo de forma metódica, garantizando consistencia en la valoración de ambos grupos y minimizando posibles prejuicios durante el proceso de observación. Con estos instrumentos metodológicos, se intentó adquirir datos exactos y comparativos acerca de la eficacia de cada método tecnológico en el proceso de aprendizaje de los alumnos.

Resultados y discusión

Para el primer ejercicio se tiene como contexto un jurado el cual debe estar constituido por 12 personas, se tiene una población inicial de 25 personas, de las cuales son 14 hombres y 11 mujeres. Se identifica

que es un muestreo sin reemplazo, además de que los elementos de éxito y de fracaso pueden hombres y mujeres en el mismo conjunto respuesta. Por lo tanto, se trata de una distribución hipergeométrica. Luego, la función de masa de probabilidad es la ecuación siguiente

$$P(X = x) = \frac{(\,_{11}C_x)(\,_{14}C_{12-x})}{(\,_{25}C_{12})}$$

De acuerdo con esto la probabilidad de que el jurado este compuesto por 6 mujeres y 6 hombres, es la siguiente

$$P(X = 6) = \frac{(\,_{11}C_6)(\,_{14}C_6)}{(\,_{25}C_{12})} = 0.2667$$

Lo cual se corrobora con la aplicación. Ver figura 4.

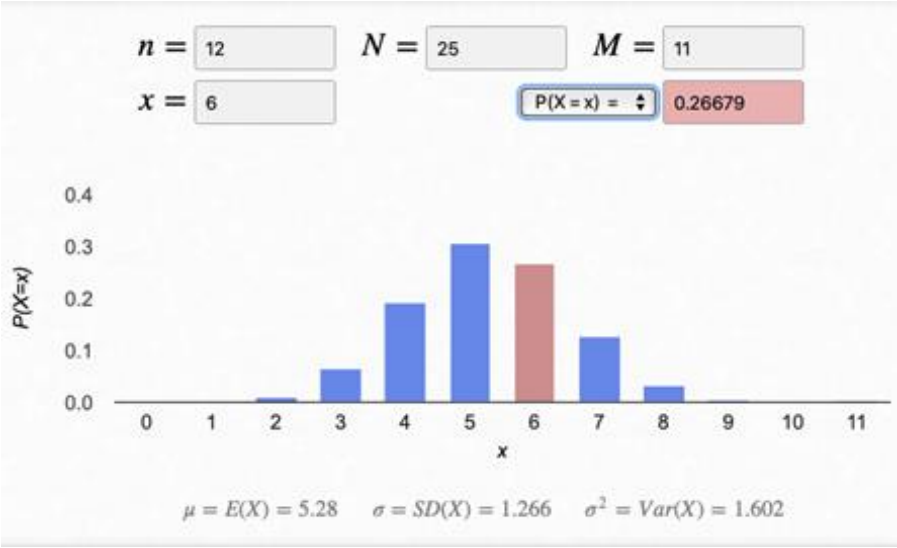

Figura 4. Grafica de la distribución hipergeométrica, para P(X=6).

Para el cuestionamiento sobre la probabilidad de que al menos 3 mujeres sean elegidas, modifica la ecuación de la siguiente manera

$$P(X \geq 3) = 1 - P(X < 3)$$
$$1 - [P(X = 0) + P(X = 1) + P(X = 2)] = 0.9886$$

A continuación, se muestra la gráfica obtenida, figura 5.

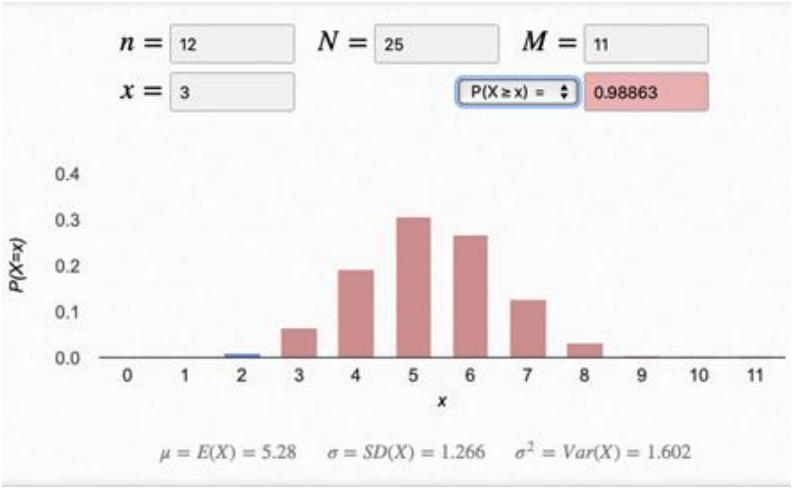

Figura 5. Grafica de la distribución hipergeométrica, para P(X>=3).

Para el ultimo cuestionamiento sobre el numero esperado de mujeres, solo basta observar la parte baja de la imagen anterior y menciona que es E(X)=5.28.

Comparando la respuesta con los alumnos, los datos obtenidos son los siguientes: En el primer caso se identifica la probabilidad de que seis mujeres participen como parte del jurado. En el segundo inciso se presentan complicaciones al manejar el juego de palabras como “de que al menos” o “a lo mucho”. Por lo tanto, se observa que solo determina la probabilidad para que tres mujeres exactamente participen como parte del jurado. Otro de los puntos donde se presenta confusión es con la esperanza matemática. Ya que el dato si lo redacto, pero no pudo interpretarlo. Para la redacción de una conclusión general, el estudiante logra identificar que este tipo de fenómenos sociales, involucran una probabilidad que relativamente es mínima. Ver figura 6.

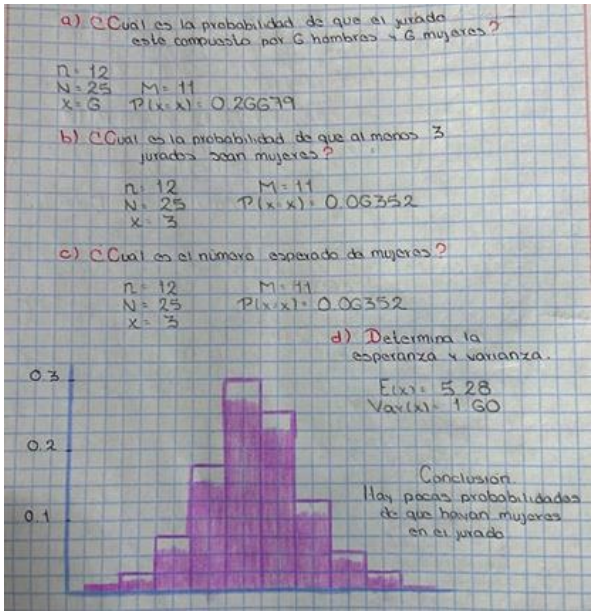

Figura 6. Repuesta de un alumno para la distribución hipergeométrica.

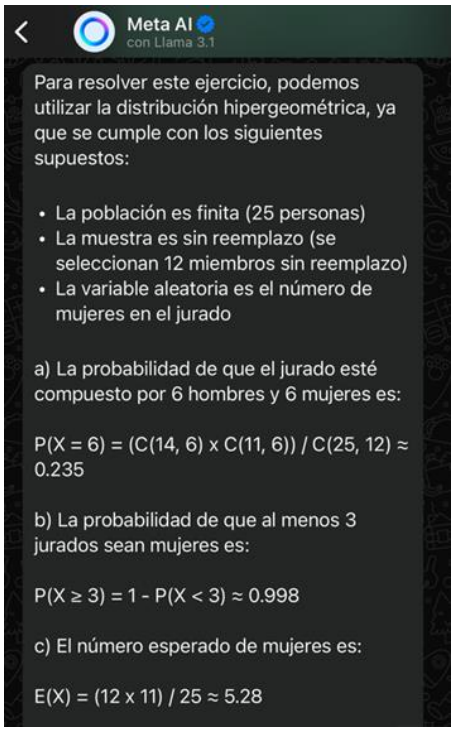

Figura 7. Repuesta de Meta IA para la distribución hipergeométrica.

Este mismo ejercicio se redactó en Meta IA, obteniéndose un análisis previo para determinar el tipo de Distribución a utilizar, para este caso es la hipergeométrica. Logra identificar la población, el tamaño de muestra, y la variable prueba, que fueron las mujeres. Se propone el método de resolución, de los incisos a, y b, sin embargo, presentan una diferencia del 11 % con respecto al valor real. El inciso c lo determinan correctamente. La IA no puede generar una gráfica de las probabilidades, y también se observa en el conjunto de probabilidades un error. Donde el valor real es de P(X=3) =0.06352, mientras que la IA obtiene un valor de P(X=3) =0.206.

IA redacta una conclusión combinando todos los elementos calculados. A lo cual, al estudiante, le cuesta trabajo el poder redactar 50 palabras. Ver figuras 7 y 8.

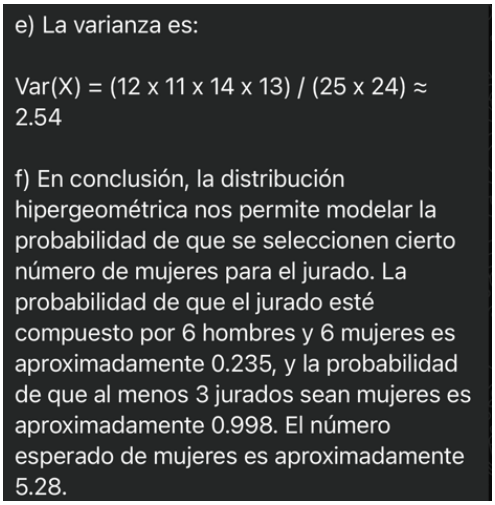

Figura 8. Repuesta de Meta IA para la distribución hipergeométrica.

El segundo ejercicio, tiene como contexto el nacimiento de una persona, que puede ser del género femenino o masculino. Se determina que la presentarse solo dos posibles eventos, y 10 experimentaciones, será una distribución binomial. A la vez, menciona que la probabilidad de que sea varón o mujer es la misma, por lo tanto, p y q serán iguales a 0.5. por lo tanto, la función de probabilidad de masa será la siguiente:

$$P(X) = \binom{10}{x}(0.5)^x(1-0.5)^{10-x}$$

Para determinar la probabilidad de que como máximo nazcan tres niños, se determina de la siguiente manera.

$$P(X \leq 3)$$
$$P(X=0) + P(X=1) + P(X=2) + P(X=3)$$
$$P(X \leq 3) = 0.17188$$

La grafica se muestra en la figura 9.

Para el inciso b, el resultado es similar, ya que al tener la misma probabilidad de éxito y de fracaso se comporta como una curva simétrica. Entonces la probabilidad de que nazcan como mínimo 3 varones de 0.17188. Para la probabilidad de que nazcan entre 4 y 6 varones se realiza con la sumatoria por lo tanto es 0.65625. La esperanza matemática se observa en la figura anterior la cual es de E(X)=5 niños y la varianza es de 2.5. El alumno en su resolución logra calcular las probabilidades de que como máximo nazcan tres niños y como mínimo 7 varones. Al propone un rango, solo determino un solo valor. Ver figura 10.

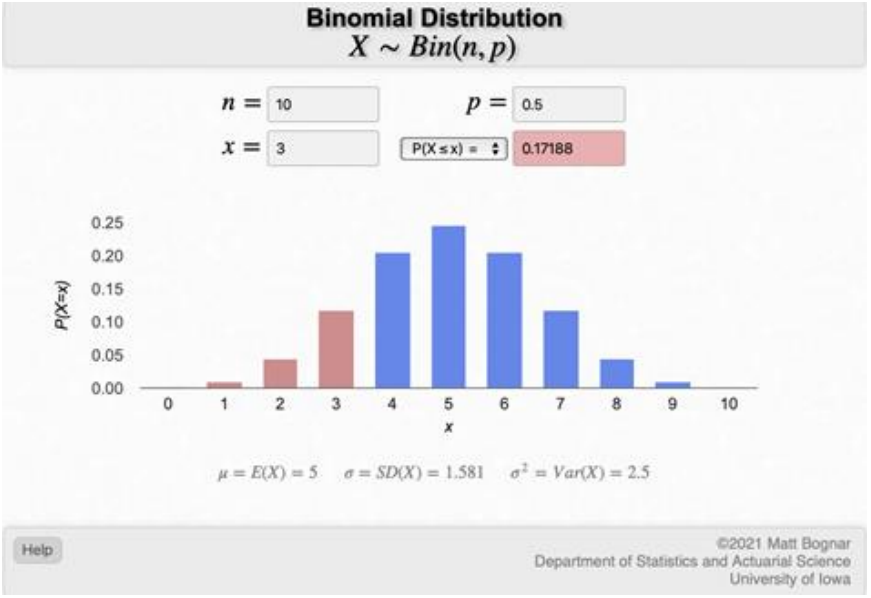

Figura 9. Grafica de la distribución binomial sobre el nacimiento.

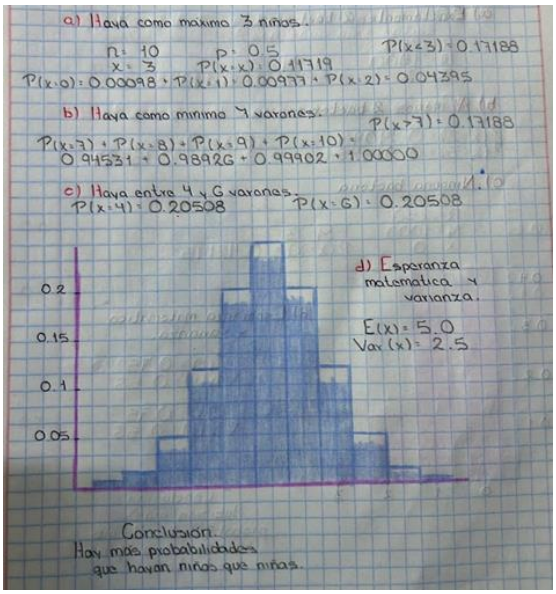

Figura 10. Repuesta de un alumno para la distribución binomial.

Se puede observar que META IA, no puede generar de manera inmediata, los cálculos a pesar de determinar la distribución binomial. Pero presenta los pasos para poder generar la gráfica en la aplicación Probability Distribution. Ver figuras 11 y 12.

Para la distribución se Poisson se observa los siguiente. Menciona que existe 3 bacterias por cada litro de agua de un lago. Y se obtiene una muestra de 250 ml, por lo tanto, se tiene que existen 3 bacterias por cada 1000 ml.

Se tiene un suceso raro, y por lo tanto, es una distribución de Poisson, la cual actúa como procesos estocástico ya que se trata de muestreo por volumen. Se tiene que identificar el promedio de bacterias que pudieran existir por cada 250 ml, la cual viene de referencia del muestreo.

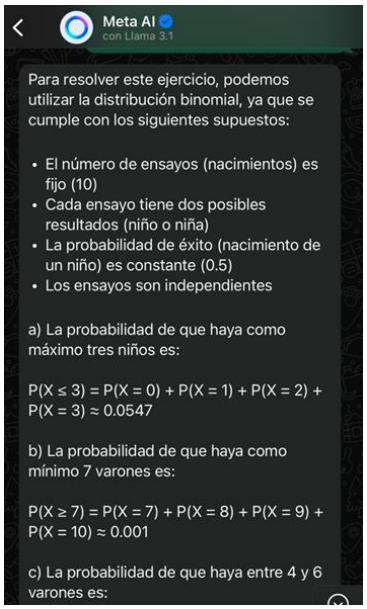

Figura 11. Repuesta de Meta IA para la distribución binomial.

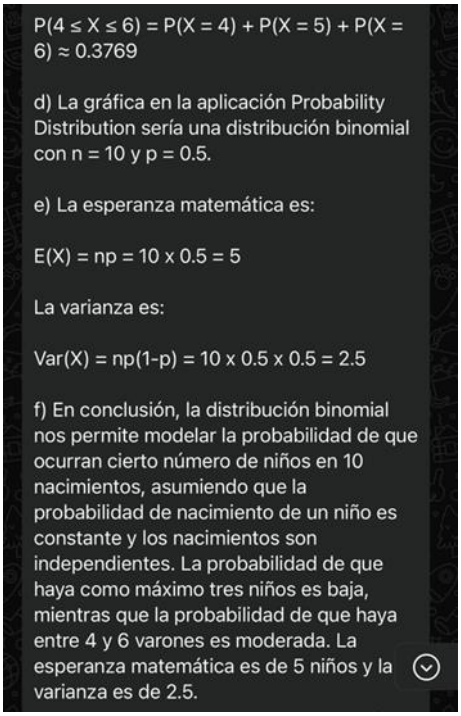

Figura 12. Repuesta de Meta IA para la distribución binomial.

Se tiene

$$\lambda = 250\ ml \times (3\ bacterias)/(1000\ ml) = 0.75\ bacterias$$

Por lo tanto, la función de probabilidad de masa esta generada por:

$$P(X = x) = \frac{e^{-0.75} * 0.75^{x}}{x!}$$

La grafica de la función es la figura 13.

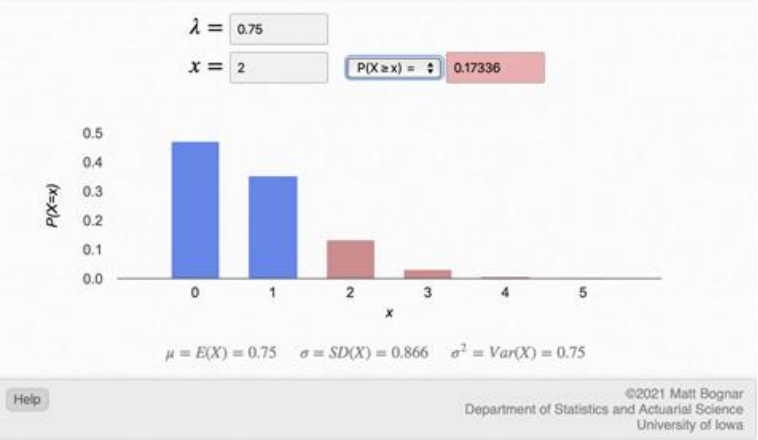

Figura 13. Grafica de la distribución de Poisson de bacteria en el agua.

Para la identificación de dos bacterias exactamente en la muestra de agua, se tiene el siguiente calculo,

$$P(X = 2) = \frac{e^{-0.75} * 0.75^2}{2!} = 0.13285$$

Para determinar que al menos dos bacterias se encuentran en la muestra, se calcula la probabilidad de que existan menos de 2 bacterias.

$$P(X \geq 2) = 1 - P(X < 2) = 1 - (P(X = 0) + P(X = 1))$$

La probabilidad es de 0.1733: por otro lado, la probabilidad de que no se encuentre ninguna bacteria en la muestra es de

$$P(X = 0) = \frac{e^{-0.75} * 0.75^0}{0!} = 0.472367$$

Por parte de los alumnos, se observó una resolución incorrecta. Donde no tuvieron la capacidad de identificar la distribución de Poisson, y se consideró o binomial o hipergeométrica. Figura 14.

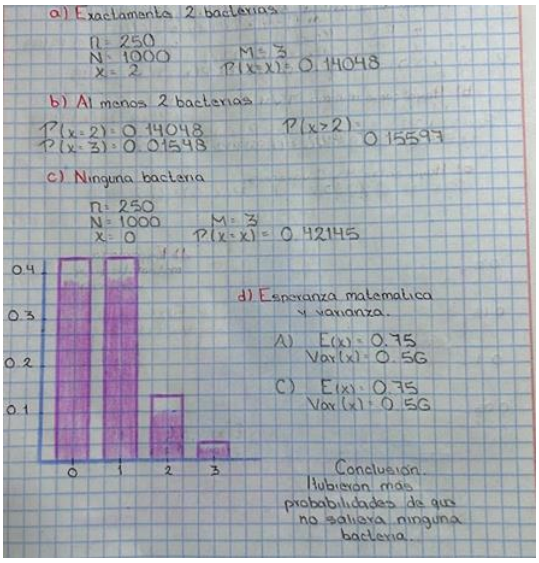

Figura 14. Repuesta de un alumno para la distribución Poisson.

Por parte de Mate IA, se observa que identifica correctamente la distribución por la cual se debe calcular. Identifica de manera correcta el promedio de bacterias por los 250 ml de muestreo. a pesar de redactar de manera correcta la ecuación de resolución, al determinar el valor obtuvo un error del 38 %, para la primera respuesta. Muy diferente a la obtenida con la distribución hipergeométrica. En la segunda respuesta se presenta un error del 17%. Para la probabilidad de no encontrar bacterias, se obtiene el resultado correcto, pero también se observa que es una ecuación matemática sencilla. Ver figura 15 y 16.

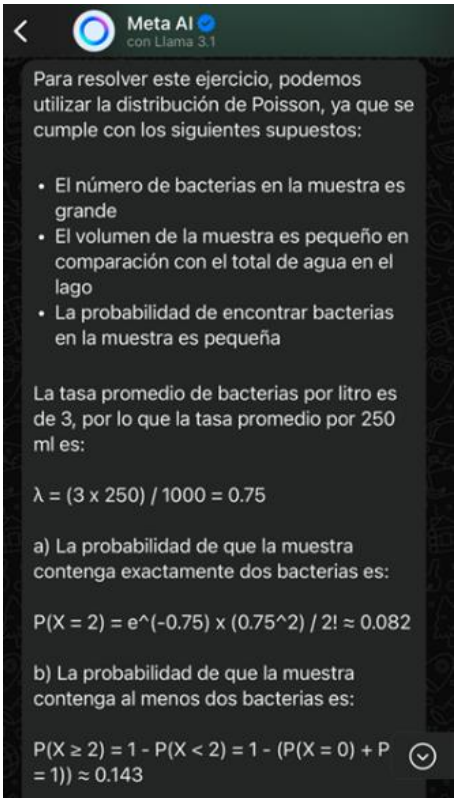

Figura 15. Repuesta de Meta IA para la distribución binomial.

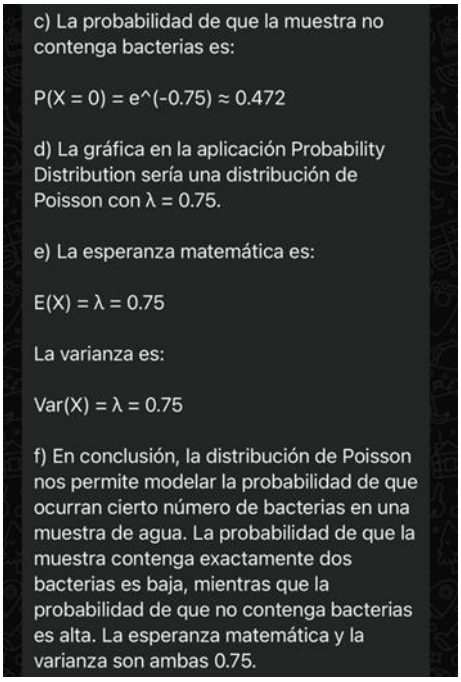

Figura 16. Repuesta de Meta IA para la distribución binomial.

Como característica positiva se observa, que el alumno puede recibir una asistencia en tiempo real para poder desglosar o determinar las características principales para identificar los elementos de cada una de las distribuciones aleatorias discretas.

De acuerdo con los resultados obtenidos se califica de la siguiente manera la guía de observación, tabla 4.

Tabla 4.
Datos comparativos.

Criterio	Cumple
Comprensión de los conceptos de la distribución	Meta IA
Precisión en los cálculos de probabilidades	TIC
Habilidad para generar gráficos y visualizaciones correctas	TIC
Claridad en la presentación de conclusiones	Meta IA

Se pueden plantear problemas complejos al ChatGPT y trabajar en equipo para descomponer el problema en pasos más manejables; además, la IA les puede ayudar a los estudiantes a identificar errores comunes y proporcionar sugerencias para corregirlos (Gavira Durón, 2023).

Pero se deberá tener cuidado con los riesgos ante los que estamos expuestos tanto los estudiantes como los profesores por el mal uso y abuso que se realiza con dicha herramienta que, sin una guía adecuada, puede generar soluciones erróneas en problemas matemáticos de alto nivel, además de que se puede perder el pensamiento crítico (Sarrazola, 2023).

Gracias a la mediación de la tecnología en los procesos de enseñanza y aprendizaje, es el docente quien se convierte en el epicentro de este proceso puesto que es éste quien autorregula el transcurso de la acción. Es decir, que gracias a las inmensas posibilidades que ofrece la tecnología se puede adaptar y personalizar la mediación educativa, lo cual repercute en el desarrollo de su aprendizaje (Martinez-Baquero & Rodríguez-Umaña, 2022).

Desde esta perspectiva se requiere la necesidad de posicionar el celular como un recurso más del proceso pedagógico, se debe concientizar al estudiante en el uso racional y responsable considerándolo como una estrategia para vencer la apatía hacia el aprendizaje y mostrarles que las nuevas tecnologías no sólo sirven para entretenerse, sino que también pueden ser un aliado en la construcción del conocimiento. (Dillan, 2011; Álvarez Álvarez & Jiménez Ruiz, 2022)

Por lo tanto, será necesario en trabajos posteriores de importancia proponer una planeación didáctica que involucre a las aplicaciones móviles trabajando en conjunto con la inteligencia artificial de Meta IA. Con la finalidad de apoyar el aprendizaje y aplicaciones de los conceptos matemáticos dentro del salón de clases.

Los hallazgos mostraron variaciones notables en el rendimiento entre la aplicación móvil y la Meta IA. Aunque la aplicación móvil sobresalió en el fortalecimiento de destrezas prácticas y la solución de ejercicios estructurados, Meta AI demostró una mayor eficacia en promover el pensamiento crítico y la capacidad de adaptación en diversos contextos. Estos descubrimientos evidencian la simbiosis de ambas herramientas y enfatizan la relevancia de elegir recursos tecnológicos que concuerden con los objetivos concretos de aprendizaje. En la siguiente sección se examinan en profundidad estas implicaciones, teniendo en cuenta las fortalezas y restricciones de cada método, y se muestran las conclusiones globales del estudio, junto con sugerencias para futuros estudios y usos educativos.

Conclusiones

De acuerdo con el análisis y discusión de resultados obtenidos, de la comparación de la efectividad de las

actividades de enseñanza aprendizaje con las Tecnologías del Aprendizaje y el Conocimiento, y la aplicación MetaIA, se obtuvieron las siguientes conclusiones. Al proponer el uso de la aplicación estadística, se ahorra tiempo en estar manipulando copias para cada una de las tablas y se puede enfocar al alumno en los procedimientos, análisis y en la contextualización del problema.

Se observó que los estudiantes lograron interpretar mejor los resultados al utilizar la aplicación móvil "Probability Distributions", enfocándose más en el análisis y la comprensión conceptual que en los cálculos matemáticos mecánicos. Esto coincide con estudios previos que destacan cómo las tecnologías de aprendizaje pueden facilitar la adquisición de habilidades estadísticas y matemáticas complejas al permitir una interacción más dinámica y visual con los datos (Álvarez Álvarez & Jiménez Ruiz, 2022; Horton & Hardin, 2015). Sin embargo, también se detectaron áreas de mejora, como la dificultad para identificar correctamente las distribuciones en contextos menos comunes (e.g., Poisson), lo cual sugiere la necesidad de una instrucción guiada más sólida.

Por otro lado, la IA MetaIA mostró un desempeño mixto. Aunque identificó correctamente las distribuciones en la mayoría de los casos y desglosó los cálculos paso a paso, presentó errores en los procedimientos matemáticos y resultados numéricos (por ejemplo, una diferencia del 11 % en la distribución hipergeométrica). Esto se alinea con investigaciones previas que advierten sobre la falta de precisión de las IA en problemas específicos y su dependencia de bases de datos no siempre confiables (Wardat et al., 2023; Sarrazola, 2023). No obstante, su capacidad para clasificar ejercicios y ofrecer retroalimentación estructurada representa un apoyo potencial para complementar el aprendizaje autónomo de los estudiantes.

A partir de estos hallazgos, se concluye que una integración efectiva de tecnologías de aprendizaje e IA en el aula requiere de una planeación didáctica que contemple sus limitaciones y fortalezas. Es fundamental que los docentes actúen como mediadores en el uso de estas herramientas, promoviendo su uso crítico y ético, y guiando a los estudiantes en el proceso de toma de decisiones y resolución de problemas (Martinez-Baquero, 2022). Asimismo, sería útil incorporar actividades colaborativas en las que los estudiantes trabajen en equipo con el apoyo de IA, lo que podría potenciar tanto su comprensión como su razonamiento crítico (Gavira Durón, 2023).

Finalmente, es importante señalar que esta investigación abre la puerta a estudios más amplios y profundos que evalúen el impacto cuantitativo y cualitativo de estas herramientas en la enseñanza de estadística. Futuras investigaciones podrían explorar el impacto a largo plazo de estas metodologías en el desarrollo de habilidades estadísticas o su aplicación en otras disciplinas.

Referencias bibliográficas

Agresti, A. (2018). *An Introduction to Categorical Data Analysis*. Wiley.

Agresti, A. (2021). *Statistical Methods for the Social Science*. Pearson Education.

Aho, M. (2024). *On the quality of mathematical writing produced by ChatGPT and Gemini* (Tesis Masters programme in engineering Physics an Matehamtics) Aalto University. Repositorio Institutcional de la Aalto University. https://aaltodoc.aalto.fi/server/api/core/bitstreams/663f70f0-4206-49b0-bdf3-1893109b4a65/content

Álvarez Álvarez, E., & Jiménez Ruiz, L. K. (2022). Aprendizaje móvil mediado por apps: Impacto para la innovación en ambientes educativos en América Latina. *Revista de Investigación en Ciencias de la Educación, Horizontes, 6*(26), 1-14. https://doi.org/10.33996/revistahorizontes.v6i26.490

Atlman, D. G. (1990). *Practical Statistics for Medical Research*. Chapman & Hall/CRC.

Babbie E. R. (2021). *The Practice of Social Research*. Cengage Learning.

Batanero, C., Diaz, C., Contreras, J. M., & Roa, R. (2013). El sentido estadístico y su desarrollo. *Números: Revista de Didáctica de las Matemáticas*, *(83)*, 7-18. https://drive.google.com/file/d/1wBh0ttAwK02g3AS66terPWi48hxlEKqL/view

Bolaño-García, M., & Duarte-Acosta, N. (2024). Una revisión sistemática del uso de la inteligencia artificial en la educación. *Revista Colombiana de Cirugía, 39*(1), 51-63. https://doi.org/10.30944/20117582.2365

Casella, G., & Berger, R.L. (2002). *Statistical Inference* (2nd Edition). Thomson Learning Inc.

Cenich, G., Araujo, S., & Santos, G. (2020). Conocimiento tecnológico pedagógico del contenido en la enseñanza de matemática en el ciclo superior de la escuela secundaria. *Perfiles educativos, 42*(167), 53-67. https://doi.org/10.22201/iisue.24486167e.2019.167.59276

DeGrooot, M. H., & Schervish, M. J. (2002). *Probability and Statistics*. Addison-Wesley.

Devore, J. L. (2016). *Probability and Statistics for Engineering and the Sciences*. Cengage Learning.

Dillan, A. (2011). Celulares ¿Aliados o enemigos? *Revista Clarin-educación, 18*(2), 1-4. https://pdfcoffee.com/celulares-aliados-o-enemigos-clarin-2-pdf-free.html

Durrett, R. (2019). *Probability Theory and Examples*. Cambridge University Press.

Field, A. (2013). *Discovering Statistics Using IBM SPSS Statistics: And Sex and Drugs and Rock "N" Roll* (4th Edition). Sage.

Gal, I. (2007). Adults' Statistical Literacy: Meanings, Components, Responsibilities. *International Statistical Review, 70*(1). 1-25. https://doi.org/10.1111/j.1751-5823.2002.tb00336.x

Gavira Durón, N. (2023). Cómo potenciar las habilidades matemáticas con ChatGPT. *Revista Mexicana De Bachillerato a Distancia, 15*(30), 1-5. https://doi.org/10.22201/cuaieed.20074751e.2023.30.86525

Gómez Blancarte, A. L., Chávez Aguilar, R. D., & Miranda Viramontes, I. (2022). Enfoques de la enseñanza de la estadística en los programas de estudio de educación media superior. *IE Revista De Investigación Educativa De La REDIECH*, *13*, 1-24. https://doi.org/10.33010/ie_rie_rediech.v13i0.1394

Grimmett, G., & Stirzaker, D. (2020). *Probability and Random Processes*. Oxford University Press.

Guadarrama Bustos, L., & Aguilar Lopez, M. A. (2021). *Introduccion al Analisis Estadistico*. Centro de Investigacion en Matematicas.

Gujarati, D.N., & Porter, D.C. (2009). *Basic Econometrics* (5th Edition). McGraw Hill.

Horton, N. J., & Hardin, J. S. (2015). Teaching the Next Generation of Statistics Students to "Think With Data": *Special Issue on Statistics and the Undergraduate Curriculum. The American Statistician, 69*(4), 259–265. https://doi.org/10.1080/00031305.2015.1094283

Inzunza Cazares, S., & Islas Anguiano, E. (2019). Análisis de una trayectoria de aprendizaje para desarrollar razonamiento sobre muestras, variabilidad y distribuciones muestrales. *Educación matemática, 31*(3), 203-230. https://doi.org/10.24844/EM3103.08

Kleinbaum, D. G. & Klein, M. (2012). *Survival Analysis. A self-Learning Text. Statistics for Biology and Health.* Springer. http://www.uop.edu.pk/ocontents/survival-analysis-self-learning-book.pdf

Korkmaz Guler, N., Dertli, Z. G., Boran, E., & Yildiz, B. (2024). An artificial intelligence application in mathematics education: Evaluating ChatGPT's academic achievement in a mathematics exam. *Pedagogical Research, 9*(2), 1-12. https://doi.org/10.29333/pr/14145

Lopezosa, C., Pérez-Montoro, M., & Rey Martín, C. (2024). El uso de la inteligencia artificial en las redacciones: propuestas y limitaciones. *Revista De Comunicación, 23*(1), 279–293. https://doi.org/10.26441/RC23.1-2024-3309

Mabel-Tauber, L., Alvarado Martínez, H., Zapata-Cardona, L., Pinto Sosa, J. E., & Albert Huerta, A. (2019). Experiencias de enseñanza sobre probabildiad y estadistica. Propuestas paa la enseñanza de mateamticas. *Acta Latinoamericana de Matematica Educativa, 32*(1), 316-326. https://funes.uniandes.edu.co/wp-content/uploads/tainacan-items/32454/1153463/Mabel2019Experiencias.pdf

Martinez-Baquero, J. E., & Rodríguez-Umaña, L. A. (2022). Uso de aplicaciones móviles como herramienta de apoyo tecnológico para la enseñanza con metodología steam. *Revista Politécnica, 18*(36), 75–90. https://doi.org/10.33571/rpolitec.v18n36a6

Montgomery, D. C., & Runger, G. C. (2018). *Applied Statistics and Probability for Engineers*. John Wiley & Son.

Moore, D. S., McCabe, G. P., y Alwan, L. (2017). *Introduction to the Practice of Statistics* (9th Edition). W.H. Freeman and Company.

Pagano, M., & Gauvreau, K. (2018). *Principles of Biostatistics* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9780429489624

Rice, J. A. (2006). *Mathematical Statistics and Data Analysis*. Thomson/Brooks/Cole.

Romero Villafranca, R., & Zunica Ramajo, L. (2013). *Metodos estadisticos para ingenieros*. Editorial Universitat Politècnica de València.

Rosner, B. (2006). *Fundamentals of Biostatistics*. Cengage Learning.

Ross, S. M. (2019). *Introduction to Probability Models*. Academic Press.

Sarrazola, A. (2023). Uso de ChatGPT como herramienta en las aulas de clase. *Revista EIA, 20*(40), 1–23. https://doi.org/10.24050/reia.v20i40.1708

Sulym, V., Melnykov, A., Popov, M., Vechirko, O., & Malets, D. (2023). Improving education through implementation of information technologies into the educational process. *Amazonia Investiga*, *12*(68), 281–293. https://doi.org/10.34069/AI/2023.68.08.26

Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(7), 1-18. https://doi.org/10.29333/ejmste/13272

Wasserman, L. (2004) *All of Statistics. A Concise Course in Statistical Inference*. Springer.

Wooldridge, J. M. (2020). *Introductory Econometrics: A Modern Approach*. Cengage Learning.

Zapata Cardona, L. (2011). ¿Cómo contribuir a la alfabetización estadística? *Revista Virtual Universidad Católica Del Norte, 1*(33), 234–247. https://revistavirtual.ucn.edu.co/index.php/RevistaUCN/article/view/4

Check for updates

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.16

Cómo citar:
Hryn, O., Kulyk, I., Petrechenko, I., Tsypliak, N., & Yasnovska, L. (2024). Enhancing students' critical thinking skills through project-oriented education. *Revista Eduweb*, *18*(4), 241-250. https://doi.org/10.46502/issn.1856-7576/2024.18.04.16

Enhancing students' critical thinking skills through project-oriented education

Mejora de la capacidad de pensamiento crítico de los alumnos mediante la educación orientada a proyectos

Olena Hryn
https://orcid.org/0000-0001-8307-8070
olenagreen5@ukr.net
Ph.D. in History, Associate Professor, Department of History of Ukraine, Archeology and Local History, O. M. Lazarevsky Educational and Research Institute of History, Social Sciences and Humanities, T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine.

Iryna Kulyk
https://orcid.org/0000-0002-9898-0064
22Kulik@gmail.com
Ph.D. in Pedagogy, Associate Professor, Department of Pedagogy and Methodology of Teaching History and Social Disciplines, O. M. Lazarevsky Educational and Research Institute of History, Social Sciences and Humanities, T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine.

Iryna Petrechenko
https://orcid.org/0000-0001-6677-1260
petrechenko-ie@ukr.net
Ph.D. in History, Associate Professor, Department of History of Ukraine, Archeology and Local History, O. M. Lazarevsky Educational and Research Institute of History, Social Sciences and Humanities, T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine.

Nataliia Tsypliak
https://orcid.org/0000-0002-7874-1277
nata.tsyplyak@gmail.com
Ph.D. in History, Associate Professor of the Departament of Word History and International Relations, O. M. Lazarevsky Educational and Research Institute of History, Social Sciences and Humanities, T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine.

Liudmila Yasnovska
https://orcid.org/0000-0001-9590-8254
lusiajasnovskaja@ukr.net
Ph.D. in History, Associate Professor, Department of History of Ukraine, Archeology and Local History, O. M. Lazarevsky Educational and Research Institute of History, Social Sciences and Humanities, T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine.

Recibido: 02/11/24
Aceptado: 19/12/24

Abstract

The article is devoted to the study and evaluation of the level of development of student's critical thinking through project-based learning. The article analyses the formation and development of critical thinking using project-based learning methods. During the experiment, the control group in these subjects was taught according to the standard curriculum, while the experimental group used project-based learning. During the experiment, criteria

and levels of students' critical thinking development through project-based learning were formed, and their characteristics were outlined. A questionnaire for assessing the development of student's critical thinking through project-based learning was developed based on the identified levels and criteria. Based on the outlined criteria, the results of developing students' critical thinking before and after the experiment are presented. It was determined that after the experiment, the average critical thinking score of students in the control group remained average. In contrast, the specified indicator in the experimental group reached a high level. In the study, the authors concluded that project-based learning is an effective tool for developing students' critical thinking, as it helps integrate theoretical knowledge with practical activities.

Keywords: critical thinking, project-based learning, students, educational institutions, STEM.

Resumen

El artículo está dedicado al estudio y la evaluación del nivel de desarrollo del pensamiento crítico de los alumnos mediante el aprendizaje basado en proyectos. El artículo analiza la formación y el desarrollo del pensamiento crítico mediante métodos de aprendizaje basados en proyectos. Durante el experimento, el grupo de control de estas asignaturas recibió la enseñanza según el plan de estudios estándar, mientras que el grupo experimental utilizó el aprendizaje basado en proyectos. Durante el experimento, se formaron criterios y niveles de desarrollo del pensamiento crítico de los alumnos mediante el aprendizaje basado en proyectos, y se esbozaron sus características. A partir de los niveles y criterios identificados, se elaboró un cuestionario para evaluar el desarrollo del pensamiento crítico de los alumnos mediante el aprendizaje basado en proyectos. Sobre la base de los criterios establecidos, se presentan los resultados del desarrollo del pensamiento crítico de los alumnos antes y después del experimento. Se determinó que, tras el experimento, la puntuación media del pensamiento crítico de los alumnos del grupo de control seguía siendo media. En cambio, el indicador especificado en el grupo experimental alcanzó un nivel alto. En el estudio, los autores concluyeron que el aprendizaje basado en proyectos es una herramienta importante para desarrollar el pensamiento crítico de los estudiantes, ya que ayuda a integrar los conocimientos teóricos con las actividades prácticas.

Palabras clave: pensamiento crítico, aprendizaje basado en proyectos, estudiantes, instituciones educativas, STEM.

Introduction

The modern educational process aims to develop competences that allow students to adapt to a rapidly changing world, analyse a large amount of information, make informed decisions and solve complex problems. The ability to think critically is one of the critical competences, including the skills of analysing, synthesising, and evaluating information and the ability to ask questions and draw reasonable conclusions.

The key characteristics of project-based learning include engaging students in practice-oriented tasks, enhancing the learning process by fostering collaboration skills, and developing critical thinking. Considering societal transformations and the need to prepare students for future professional challenges, project-based learning also cultivates the ability to address cultural challenges and actively engage in social life. STEM education provides opportunities to utilise interdisciplinary connections, enhance practical skills, and integrate into societal practices and modern technologies.

The article focuses on the impact of project-based learning on the development of critical thinking in secondary school students.

Literature Review

The development of students' critical thinking is an effective strategy for fostering not only critical thinking but also collaborative skills and proficiency in information technology (Yadollahi et al., 2022). Implementing student projects involves the stages of planning, execution, and peer evaluation of work (Vathanakulkachorn et al., 2023). The ability to reflect is one of the key competencies of project-based

learning (Weiland et al., 2024; Chikurteva, 2023), and collaborative learning enhances students' analytical skills (Long et al., 2021). The study focuses on the application of the project-based approach in the context of chemistry education (Khambuo et al., 2024). Such an educational approach not only supports the generation of self-knowledge but also promotes the development of critical thinking skills, which are crucial for constructing knowledge (Muschkin et al., 2024).

The article describes a large-scale project-based learning programme based on the application of the "flipped classroom" technology (Inoue et al., 2020). This approach is widely used to encourage active and autonomous learning among students and ensures the quality of education (Kang & Gim, 2022; Jiang & Yuan, 2020). The study focused on students participating in online learning with a project-based approach (Deroncele-Acosta et al., 2021; Dewi & Kristanto, 2019). Based on the study's results, student engagement determines students' learning motivation (Hidayah & Arum, 2021). The results of the study reveal students' motivation and interest in learning the subjects, as well as the approval of the project-based learning approach by the students and the professor involved (Sales & Boscarioli, 2021).

The findings of the study can be applied to the development of curricula for subjects related to project-based learning, taking into account the formation of educational competencies (Joko et al., 2022). The article examines the readiness of future teachers to teach in blended and online formats using project-based learning methods (Nuraini et al., 2021). The ability to apply project-based learning methods significantly impacts the readiness of future teachers for professional activities (Hu et al., 2020). This readiness should be accompanied by a continuous process of developing skills for optimisation and adaptation to various teaching formats (Samarakoon et al., 2021).

Since critical thinking based on reasoning and evidence is a core competence for today's students, it is necessary to help students develop their critical thinking through project-based learning (Gou et al., 2024). It is also necessary to promote research that examines the relationship between specific project-based learning offerings and specific skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Students' critical thinking is developed through the performance of these cognitive tasks in STEM projects (Dotsenko, 2023); they develop skills in researching and identifying relevant sources, analysing the information found, expressing reasoned opinions and evaluating their work, looking for ways to improve it (Batsurovska et al., 2024).

Project-based learning is a powerful tool for fostering critical thinking in the school curriculum, especially in the context of the New Ukrainian School (NUS) (Barkovska et al., 2024). In today's context, project-based learning is becoming a necessary tool for preparing young people for a complex and dynamic world (Manikutty et al., 2024; Mujtaba et al., 2024; Permana & Utomo, 2020), so the study of the formation and development of critical thinking through project-based learning is an important and relevant topic for research in modern pedagogical practice.

Methodology

The study used *survey* methods*, comparison of learning outcomes and experimentation*.

The essence of the experiment involved the implementation, during the 2023–2024 academic year, of a study based on 9th-grade students at Secondary School No. 201 in Kyiv. For the control group, the New Ukrainian School (NUS) programme was applied, while for the experimental group, a combination of the NUS programme and project-based learning was implemented for biology, Ukrainian history, and informatics. Surveys were conducted among teachers based on developed criteria to assess the impact of project-based learning on the development of students' critical thinking. The academic outcomes of students in the control and experimental groups were compared both before and after the experiment.

A total of 45 students took part in the experiment. The control group consisted of 22 students, and the experimental group consisted of 23 students.

The assessment of the formation and development of student's critical thinking through project-based learning was carried out by calculating the arithmetic mean of the two indicators:

1. Learning outcomes. Score on a 12-point scale of the students in the classroom on the project.
2. Self-assessment of critical thinking development through project-based learning. According to the developed criteria, a questionnaire for teachers was created to determine students' critical thinking levels through project-based learning.

In addition, to assess the development of students' critical thinking, the levels of critical thinking formation were outlined: basic, intermediate and high. The characteristics of each level are outlined to assess the development of student's critical thinking.

Results

The State Standard of Basic Secondary Education identifies the main competences of students, which include fluency in the state language, the ability to communicate in native (if different from the state language) and foreign languages, mathematical competence, competence in natural sciences, engineering and technology, innovation, environmental competence, information and communication competence, lifelong learning, civic and social competence, cultural competence, entrepreneurship and financial literacy (Cabinet of Ministers of Ukraine, 2020).

Critical thinking is the ability to analyse information, evaluate evidence, find logical connections, formulate arguments, and make informed decisions. Its main components are analysing a situation, searching for alternative solutions, evaluating advantages and disadvantages, and drawing conclusions.

Project-based learning is an innovative approach to education that focuses on students' active participation in creating projects, solving real-world problems, and developing critical thinking. It ensures the integration of theoretical knowledge with practical skills and contributes to developing critical competences required in the modern world.

Figure 1 outlines the main stages of developing students' critical thinking through project-based learning.

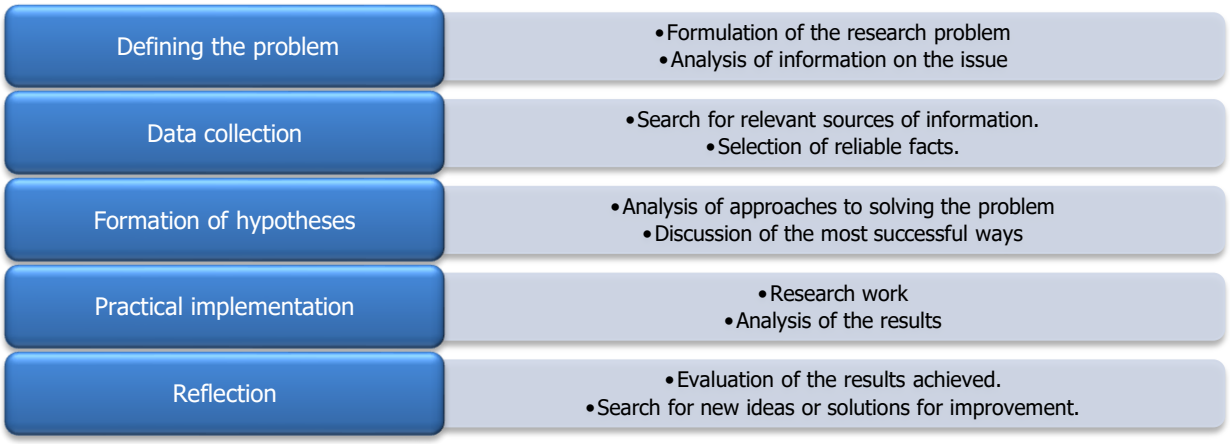

Figure 1. The main stages of developing students' critical thinking through the implementation of project-based learning
Source: compiled by the author

The levels of critical thinking development among secondary school students are presented, divided into basic (BL), intermediate (IL), and high (HL) levels. Table 1 outlines the key indicators of the basic, intermediate, and high levels of critical thinking development, which teachers can use as a reference when assessing students' academic achievements. The assessment is based on a 12-point scale, with every 4 points corresponding to a specific level.

The development of critical thinking requires clear criteria for assessing its level. These criteria help analyse students' progress and identify strengths and weaknesses in developing their thinking skills. In the course of the survey of teachers, a questionnaire was developed based on the criteria outlining the criteria and levels of critical thinking through project-based learning. For each question, which is grouped into blocks according to the criteria, it was possible to give from 0 to 4 points, thus indicating the level of critical thinking for each of the criteria; the indicator for each criterion is summed up.

Criteria have been formed for self-assessment of the effectiveness of the formation and development of students' critical thinking through project-based learning. These criteria include analytical (AnC), argumentative (ArC), creative (CC), and reflective (RC). Table 1 presents the criteria and levels of students' critical thinking development through project-based learning and their characteristics.

In the course of the experiment, the control group studied according to the regular curriculum, while the experimental group completed projects in different subjects, namely: History of Ukraine (HU), Biology (B), and Computer Science (CS). The control group consisted of 22 students, and the experimental group consisted of 23 students. Self-assessment of the results of critical thinking development was conducted through a questionnaire of subject teachers. Table 2 shows the results of students' critical thinking development before the experiment on a 12-point scale, which included the average value of learning outcomes and self-assessment.

Table 1.
Criteria and levels of students' critical thinking development through project-based learning and their characteristics

Criterion	Main features criterion	Level	The main characteristics of the level
AnC	Identifying the main thing, classifying, and identifying cause and effect relationships.	HL	Clear argumentation of connections between phenomena
		IL	Ability to identify the essence, but need help identifying cause and effect relationships.
		BL	Poor separation of important information from unimportant information
ArC	Drawing logical conclusions, justifying opinions, evaluating different points of view	HL	Logical argumentation of your point of view and consideration of different opinions
		IL	Superficial argumentation
		BL	There is no or weak argumentation.
CC	Ability to look for non-standard solutions, generate new ideas, and combine different sources of information.	HL	Finding original ways to solve problems and generating ideas.
		IL	Ability to propose well-known solutions to a problem
		BL	The use of standard approaches and lack of creativity.
RC	Ability to reflect, critically evaluate your work and look for ways to improve	HL	Awareness of strengths and weaknesses, suggestions for improvement
		IL	Detecting errors, analytical difficulties
		BL	Lack of reflection or weak reflection.

Source: compiled by the author

Table 2.
Results of students' critical thinking development before the experiment

Criterion/ Subject	CG before the experiment				EG before the experiment			
	HU	B	CS	Average	HU	B	CS	Average
AnC	7	6	7	6,7	8	7	8	7,7
ArC	8	5	8	7,0	7	5	7	6,3
CC	6	8	5	6,3	6	8	6	6,7
RC	5	7	7	6,3	6	7	6	6,3
Average	6,5	6,5	6,8	6,6	6,8	6,8	6,8	6,8

Source: compiled by the author

Tables 2 and 3 present the following conventions: AnC, ArC, CC, and RC are criteria for assessing the development of students' critical thinking (according to Table 1); EG and CG are experimental and control groups; HL, IL, BL are high, intermediate, and basic levels of students' critical thinking development; HU, B, CS are results of the formation and development of students' critical thinking in the history of Ukraine, biology, and computer science, respectively.

In the course of the experiment, it can be concluded that in the control and experimental groups, the average level of critical thinking development before the experiment was at an average level and reached 6.7 and 6.8 points out of 12 possible, respectively.

Table 3 shows the generalised results of students' critical thinking development after the experiment.

Table 3.
Results of students' critical thinking development after the experiment

Criterion/ Subject	CG after the experiment				EG after the experiment			
	HU	B	CS	Average	HU	B	CS	Average
AnC	8	7	8	7,7	9	10	9	9,3
ArC	7	6	7	6,7	10	9	9	9,3
CC	7	6	6	6,3	11	10	10	10,3
RC	6	6	6	6,0	9	9	9	9,0
Average	7,0	6,3	6,8	6,7	9,8	9,5	9,3	9,5

Source: compiled by the author

After the experiment, the average critical thinking score of students in the control group remained virtually unchanged and reached 6.8 points. At the same time, in the experimental group, which used project-based learning methods to study the subjects selected for the experiment, the average critical thinking score reached 9.5 points, indicating a high level of formation and development of students' critical thinking.

The main goal of the pedagogical experiment was to substantiate the use of project-based learning to develop students' critical thinking. Figure 2 shows a general visualisation of the effectiveness of project-based learning in developing students' critical thinking in different subjects: history of Ukraine, biology, and computer science.

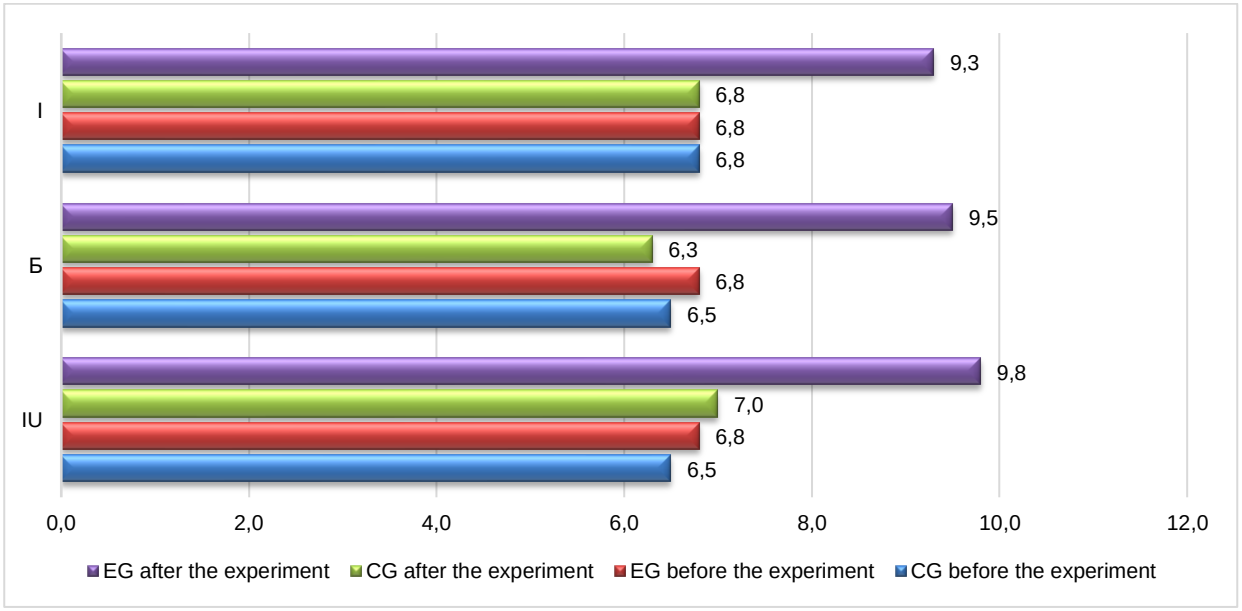

Figure 2. General visualisation of determining the effectiveness of project-based learning in developing students' critical thinking
Source: developed by the author

As can be seen from Figure 2, the control group's scores in the three subjects are at an average level, while the experimental group's scores increased by 3-4 points during the experiment and reached a high level.

Project outcomes include a presentation on the history of Ukraine in the form of a poster, video, or multimedia work; a booklet, presentation, poster, or video with recommendations on biology; and a website that can be published or used as a teaching resource in computer science.

It has been determined that project-based learning improves learning outcomes, allows students to gain in-depth knowledge in relevant areas, and promotes critical thinking, creativity, and teamwork.

Discussion

Critical thinking has become a keyword in educational theory and practice over the past few decades. Students' critical thinking abilities have been studied, and their learning processes have been analysed through game behaviour (Chuang et al., 2024). The results show that the group performed better with project-based learning, which confirms the main advantages of the method for achieving the goals of 21st-century education (Chikurteva, 2023; Kuzmina et al., 2020). Evaluating different points of view and checking facts encourages students to make informed decisions. The exchange of ideas and constructive criticism occurs during projects, developing individual and collective critical thinking. It is also helpful to complete interdisciplinary projects, which helps to better understand interdisciplinary connections.

Integrating project-based learning models and online learning methods led to the creation of the online project-based learning model. The online project-based learning model has been declared suitable for use in graphic media development subjects (Dewi & A. Kristanto, 2019). However, project-based learning challenges include high planning requirements, uneven responsibilities between students during the project, complexity of assessment, and psychological barriers. Overcoming these challenges requires proper teacher training, careful material selection, and adherence to the sequence of project stages. Explicit criteria for assessing each student should also be followed, and the assessment should also consider the work process and the teacher's motivation.

Learning skills include acquiring essential knowledge and concepts in many dimensions, such as problem-solving, critical thinking, creative thinking and decision-making. An assessment approach designed to assess higher-order thinking skills is presented. The evaluation of higher-order thinking skills includes four sub-skills of thinking, i.e. problem-solving, critical thinking, creative thinking and decision-making. The learning skills are assessed according to how well students respond to the suggested questions to focus their thinking and how well these questions help students complete the tasks. A skills assessment approach can reveal skills without interfering with the typical learning activities associated with a given task (Alkhatib, 2022). The key components of critical thinking are analysis, evaluation, synthesis, and reflection. Students learn to look at a problem from different angles, develop the ability to verify information and discard irrelevant information. Students create new ideas or approaches based on their knowledge and analyse their strengths and weaknesses during the project. Integrating project-based learning into the modern education system is a powerful tool for developing critical thinking in students and the first step in preparing them to solve complex problems in the future.

Conclusions

The primary focus of this investigation is to examine enhancing students' critical thinking skills through project-oriented education. The study revealed that through the project-based learning method, students learn to analyse information, formulate clear arguments, make informed decisions and present their ideas. Project-oriented education develops analytical skills, improves argumentation skills, fosters creativity, promotes cooperation, and increases independence and responsibility. Data were collected through a series of the average learning outcomes and subject teachers' self-assessments to determine the level of development of students' critical thinking through project-based learning. The findings suggest a correlation of four criteria for developing critical thinking in students are outlined: analytical, reflective, creative and argumentative. Three levels of critical thinking development in students are also presented: basic, intermediate and high, and the indicators of these levels are described.

It was observed results of three subjects were chosen for the experiment: history of Ukraine, biology, and computer science. During the school year, students in the control group studied the standard curriculum, while students in the experimental group used project-based learning. At the end of the school year, the average critical thinking score of students in the control group remained average. In contrast, the score in the experimental group reached a high level, which indicates the effectiveness of project-based learning. The results may be influenced by the fact that in the context of modern education, project-based learning is becoming an indispensable method of developing the skills necessary for a successful life in the information society. This study highlights the need for further research into technologies that helps students acquire knowledge and develop critical thinking, which is crucial to their future.

Bibliographic references

Alkhatib, O. J. (2022). An effective assessment method of higher-order thinking skills (problem-solving, critical thinking, creative thinking, and decision-making) in engineering and humanities. *2022 Advances in Science and Engineering Technology International Conferences (ASET)*, Dubai, United Arab Emirates (pp. 1–6). https://doi.org/10.1109/ASET53988.2022.9734856

Barkovska, O., Ivashchenko, H., Rosinskiy, D., & Zakharov, D. (2024). Educational training simulator for monitoring reading technique and speed based on speech-to-text (STT) methods. *Information Technologies and Learning Tools, 103*(5), 21-38. https://doi.org/10.33407/itlt.v103i5.5647

Batsurovska, I., Dotsenko, N., Gorbenko, O., Haleeva, A., & Kurepin, V. (2024). Online control of educational results of the unit "Electricity" in the conditions of blended learning. *Journal of Physics: Conference Series, 2871*, 012013. https://doi.org/10.1088/1742-6596/2871/1/012013

Cabinet of Ministers of Ukraine. (2020). *Resolution of 30 September 2020 No. 898. State standard of basic secondary education*. http://surl.li/zwhmsc

Chashechnikova, O., Odintsova, O., Hordiienko, I., Danylchuk, O., & Popova, L. (2024). Innovative technologies for the development of critical thinking in students. *Amazonia Investiga*, *13*(81), 197–213. https://doi.org/10.34069/AI/2024.81.09.16

Chikurteva, A. (2023). ICT for integrating the project-based learning method in Bulgarian education. In *2023 XXXII International Scientific Conference Electronics (ET)*. Sozopol, Bulgaria (pp. 1-5). https://doi.org/10.1109/ET59121.2023.10278743

Chuang, T.-Y., Lu, Y.-H., Tsai, S.-K., & Chen, W.-F. (2024). Examining critical thinking skills in game-based learning: A behavioural analysis approach. In *2024 16th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*. Takamatsu, Japan (pp. 148-151). https://doi.org/10.1109/IIAI-AAI63651.2024.00037

Deroncele-Acosta, A., Nagamine-Miyashiro, M., Medina-Coronado, D., Rivera-Portugal, A. M., Berroa-Garate, H. C., Flores-Llerena, D. Y., & Huarca-Flores, P. (2021). E-learning for the development of critical thinking: A systematic literature review. In *2021 XVI Latin American Conference on Learning Technologies (LACLO)*, Arequipa, Peru, (pp. 173-180). https://doi.org/10.1109/LACLO54177.2021.00072

Dewi, U., & Kristanto, A. (2019). Development of online project-based learning models. In *2019 5th International Conference on Education and Technology (ICET)*. Malang, Indonesia (pp. 127-130). https://doi.org/10.1109/ICET48172.2019.8987228

Dotsenko, N. (2023). Interactive posters as a learning tool for practical tasks in the context of electrical engineering education. In *2023 IEEE 5th International Conference on Modern Electrical and Energy System* (MEES). Kremenchuk, Ukraine (pp. 1 5). https://doi.org/10.1109/MEES61502.2023.10402463

Gou, T., Guo, D., & Fan, M. (2024). Design and empirical research of critical thinking training model based on digital science argument mapping. In *2024 International Symposium on Educational Technology (ISET)*. Macau, Macao (pp. 324-328). https://doi.org/10.1109/ISET61814.2024.00070

Hidayah, N., & Arum, A. P. (2021). Vocational student interest in applying project-based learning (PjBL) approach through Google Classroom in new normal era. In *2021 7th International Conference on Education and Technology (ICET)*. Malang, Indonesia (pp. 183-186). https://doi.org/10.1109/ICET53279.2021.9575120

Hu, H., Peng, L., Li, X., & Zhao, X. (2020). A survey of children's peer communication ability: Comparison of high vision courses with other courses. In *2020 International Conference on Big Data and Informatisation Education (ICBDIE*). Zhangjiajie, China (pp. 114-118). https://doi.org/10.1109/ICBDIE50010.2020.00033

Inoue, M., Suhara, Y., Ichikawa, M., Chen, X., & Wagatsuma, T. (2020). Planning and implementation of large-scale online project-based learning and flipped classes. In *2020 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*. Takamatsu, Japan (pp. 918-921). https://doi.org/10.1109/TALE48869.2020.9368494

Jiang, N., & Yuan, C. (2020). On current situation and improvement strategies of family-centred early education in urban areas of Chongqing. In *2020 International Conference on Big Data and Informatisation Education (ICBDIE*). Zhangjiajie, China (pp. 1-5). https://doi.org/10.1109/ICBDIE50010.2020.00064

Joko, A. B., Santoso, A. B., & Widayaka, P. D. (2022). The effect of learning readiness and prerequisite courses on project-based learning on student competencies in working on electrical machine repair projects in the post-COVID-19 transition period. In *2022 Fifth International Conference on Vocational Education and Electrical Engineering (ICVEE)*. Surabaya, Indonesia (pp. 211-215). https://doi.org/10.1109/ICVEE57061.2022.9930406

Kang, S., & Gim, G. (2022). The effect of mother's parenting behaviour on child's adjustment to school: The mediating effect of child's self-esteem. In *2022 IEEE/ACIS 7th International Conference on Big Data, Cloud Computing, and Data Science (BCD)*. Danang, Vietnam (pp. 353-359). https://doi.org/10.1109/BCD54882.2022.9900617

Khambuo, S., Tep, P., & Tanprasertkul, S. (2024). Implementing a constructionist project-based learning approach to enhance chemistry learning achievement in eleventh grade students. In *2024 9th International STEM Education Conference (iSTEM-Ed)*. Cha-am, Hua Hin, Thailand (pp. 1-5). https://doi.org/10.1109/iSTEM-Ed62750.2024.10663104

Kuzmina, M. O., Protas, O. L., Fartushok, T. V., Raievska, Y. M., & Ivanova, I. B. (2020). Formation of students' competence of tertiary educational institutions by practical training aids. *International Journal of Higher Education*, *9*(7), 279-288. https://doi.org/10.5430/ijhe.v9n7p279

Long, Y., Dong, W., & Luo, W. (2021). Research on preschool children's painting application in children's intelligent furniture. In *2021 2nd International Conference on Intelligent Design (ICID*). Xi'an, China (pp. 524-527). https://doi.org/10.1109/ICID54526.2021.00109

Manikutty, G., Potapragada, S. A., Pasupuleti, D., Unnithan, M. S., Venugopal, A., Prabha, P., ... & Bhavani, R. R. (2024). Exploring child-robot interaction in individual and group settings in India. In *2024 8th International Conference on Robotics and Automation Sciences (ICRAS*). Tokyo, Japan (pp. 37-42). https://doi.org/10.1109/ICRAS62427.2024.10654467

Mujtaba, S. J., Kigobe, J., & Van Leeuwen, K. (2024). Parental involvement in primary schools in Tanzania: Effects of a pre- and in-service teacher training. *Teaching and Teacher Education, 140*, 104459. https://doi.org/10.1016/j.tate.2023.104459

Muschkin, C., Ladd, H., & Sauval, M. (2024). Pre-K enrolments and teaching environments in North Carolina elementary schools. *Children and Youth Services Review, 164*, 107832. https://doi.org/10.1016/j.childyouth.2024.107832

Nuraini, N. L. S., Prastyo, M. H. B., & Hidayati, L. N. A. D. (2021). Readiness of preservice teachers in online learning through project-based learning. In *2021 7th International Conference on Education and Technology (ICET)*, Malang, Indonesia. (pp. 247-251). https://doi.org/10.1109/ICET53279.2021.9575110

Permana, D., & Utomo. (2020). Enhance scientific attitudes using stereoscopic 3D images in primary school. In *2020 6th International Conference on Computing Engineering and Design (ICCED)*. Sukabumi, Indonesia (pp. 1-4). https://doi.org/10.1109/ICCED51276.2020.9415763

Sales, A. B., & Boscarioli, C. (2021). Teaching and learning of interface design: An experience using project-based learning approach. In *2021 16th Iberian Conference on Information Systems and Technologies (CISTI)*. Chaves, Portugal (pp. 1-6). https://doi.org/10.23919/CISTI52073.2021.9476547

Samarakoon, S. M. U. P., Weerasinghe, T. A., & Usoof, H. (2021). Usability heuristics for early primary children: A case study in Sri Lanka. In *2021 International Conference on Computational Science and Computational Intelligence (CSCI)*, Las Vegas, NV, USA (pp. 933-939). https://doi.org/10.1109/CSCI54926.2021.00061

Vathanakulkachorn, V., Pichitpreecha, S., & Supakwong, S. (2023). Enhancing sequence coding skills in lower primary school through affordable game-based learning: A case study in Thailand. In *2023 8th International STEM Education Conference (iSTEM-Ed)*. Ayutthaya, Thailand (pp. 1-5). https://doi.org/10.1109/iSTEM-Ed59413.2023.10305796

Weiland, C., McCormick, M., Duer, J., Friedman-Krauss, A., Pralica, M., Xia, S., Nores, M., & Mattera, S. (2024). The mixed-delivery pre-k opportunity gap? Differences in demographics, quality, and children's gains in community-based versus public school programmes across five large-scale systems. *Early Childhood Research Quarterly, 68*, 247-259. https://doi.org/10.1016/j.ecresq.2024.05.004

Yadollahi, E., Couto, M., Dillenbourg, P., & Paiva, A. (2022). Motivating children to practice perspective-taking through playing games with Cozmo. In *2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN*). Napoli, Italy (pp. 1482-1489). https://doi.org/10.1109/RO-MAN53752.2022.9900523

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.17
Cómo citar:
Zelenin, V. (2024). Impact of coaching on IT specialists' professional development: An empirical analysis. *Revista Eduweb*, *18*(4), 251-264. https://doi.org/10.46502/issn.1856-7576/2024.18.04.17

Impact of coaching on IT specialists' professional development: An empirical analysis

El impacto del coaching en el desarrollo profesional de los especialistas en TI: un análisis empírico

Vsevolod Zelenin
https://orcid.org/0000-0003-1267-9308
sevacello@gmail.com
Candidate of Psychological Sciences, Docent, Professor of Department of Psychology, Faculty of Psychology, National Pedagogical Dragomanov University, Kyiv, Ukraine.

Recibido: 30/10/24
Aceptado: 21/12/24

Abstract

The role of coaching in the professional self-realisation of IT specialists is gaining relevance in the context of rapid changes in the labour market and increasing requirements for adaptability and the development of career competences. Modern IT companies increasingly use coaching techniques to improve employee performance and develop professional growth strategies. The study aims to assess the impact of coaching on the professional self-realisation of IT professionals, particularly in forming career strategies and developing critical competences. The research methodology includes literature analysis, surveys of IT professionals at different levels, and quantitative analysis of the collected data. The study results showed that individual and team coaching contributes to increased professional confidence, soft and technical skills development, and more effective career planning. It has been found that the most significant barrier to achieving career goals is the lack of technical competences and employer support, which can be addressed through the introduction of corporate coaching programmes. The study's practical significance lies in using the data to create effective professional development programmes in IT companies. The results also emphasise the importance of promoting coaching among IT professionals to ensure their competitiveness.

Keywords: coaching, education, professional self-realisation, IT specialists, career development, competences, motivation, leadership qualities, teamwork, corporate culture.

Resumen

El papel del coaching en la autorrealización profesional de los especialistas en TI está ganando relevancia en el contexto de los rápidos cambios en el mercado laboral y las crecientes exigencias de adaptabilidad y desarrollo de competencias profesionales. Las empresas de TI modernas utilizan cada vez más técnicas de coaching para mejorar el rendimiento de los empleados y desarrollar estrategias de crecimiento profesional. El estudio tiene como objetivo evaluar el impacto del coaching en la autorrealización profesional de los profesionales de TI, en particular en la formulación de estrategias profesionales y el desarrollo de competencias críticas. La metodología de investigación incluye análisis de la literatura, encuestas a profesionales de TI en diferentes niveles y análisis cuantitativo de los datos recopilados. Los resultados del estudio mostraron que el coaching individual y de equipo contribuye a aumentar la confianza profesional, el desarrollo de habilidades blandas y técnicas y una planificación profesional más eficaz. Se ha descubierto que la barrera más importante para alcanzar los objetivos profesionales es la falta de competencias técnicas y de apoyo de los empleadores, que se puede abordar mediante la introducción de programas de coaching corporativos. La importancia práctica

del estudio radica en utilizar los datos para crear programas de desarrollo profesional eficaces en las empresas de TI. Los resultados también enfatizan la importancia de promover el coaching entre los profesionales de TI para garantizar su competitividad.

Palabras clave: coaching, educación, realización profesional, especialistas en TI, desarrollo de carrera, competencias, motivación, liderazgo, trabajo en equipo, cultura corporativa.

Introduction

The processes of professional self-identity of IT specialists has been an essential issue in the world's highly dynamic and competitive job environment caused by technological development. This change makes career mobility, career self-management and competence requirements primary concern for individuals and organizations. In this regard 'coaching' has been identified as a practical solution for the process of self and organisational transformation. However, information about its application and effectiveness regarding IT specialists is still insufficient. Current studies indicate the psychological and methodological features of coaching, revealed through views on career path, motivation, and competence development (Kryukova et al., 2023; Khanetska, 2024a). The focus is on coaching, accordingly it is given to each person as well as to the team, with the problem-solving and task-completion stress. Nevertheless, the literature revealed that coaching effectiveness depends on the professional practice and cultural environment (Zobenko, 2020; Vedina et al., 2020).

Nevertheless, some areas worthy of further scientific research are still uncovered: Broad and generalizable applicability of the type of coaching programmes developed specifically for IT specialists; the inclusion of such a form of activities into organizational culture. However, there are issues regarding the availability of the services and the cost that makes the possibility of the service to reach more people a good area of study. That structure of this study is intended to cover these gaps. The first section includes a brief review of current trends in coaching and its applicability to the sphere of IT. The second section analyzes the research method used in the study and descries the means applied in data collection and analysis. The existence of coaching effects on career planning, motivation and skill enhancement, as well as limitation to implementation is also discussed under the results and discussion sections. As a final measure, the study proposes strategies for the promotion of coaching and the application of practice as the Source of Realization of Professional Self.

The purpose of this study is to evaluate the effectiveness of coaching as a means to enhance the professional self-actualization of IT specialists, identify the major characteristics of this process, and offer practical guidelines for enhancing the efficacy of the coaching process. In order to meet these aims, the study contrasts modern tendencies of coaching, assesses the leisure acquire in career management and competence development, and defines the prospects of widening the usage of coaching services proving the IT domain.

Literature Review

New research puts a lot of emphasis on coaching in the workplace, especially for career advancement and especially in information technology. According to Kryukova et al. (2023), coaching is crucial in the context of change, whereas Khanetska (2024a) underlines the necessity of career coaching to form long-term orientations for workers. According to Vedina et al. (2020), team coaching is one of the useful strategies to enhance interaction in group assignments; thus, Dzikovska (2019) stresses adding coaching methods into the learning processes to foster critical thinking. Some authors distinguish technical and soft competences. Gadatsch (2023) forcefully argues for the generation of contemporary technical abilities; Kryukova et al. (2023) perspective on the ramifications of soft skills for collaboration. Khanetska (2024b) has presented the theory of the predisposition to or orientation on the given conditions as one of the essential attributes for success. Chayka & Zelenin (2024). have stressed leadership coaching as one of the elements in the construction of strategic visions.

There are also works concerning the influence of corporate culture. Several researchers presented ideas about coaching, where Kryukova et al. (2023) and Merrill et al. (2023) suggest that it may be used to enhance the level of employee engagement and motivation, and Vedina et al. (2020) highlight that the application of coaching in organisations' strategic management is vital. Similarly, as Moura and Silva (2019) observe, coaching may impact career prioritisation and influence professional growth, as Patti and colleagues (2012) investigate. Research looks at the issue of computer specialists employing coaching to address professional ripple effects. Iswarya et al. (2024) compared the effectiveness of coaching programmes for stress reduction. Chaika (2024) submitted a paper concentrating on personality factors and success. The significance of coaching programmes to enhance job satisfaction is discussed by Purohit et al. (2021), and the analysis of professionalism development in an international context is investigated by Zaharopoulos (2024).

Coaching in the context of authentic work as a key to improved satisfaction of employees is discussed by Lozovetska et al. in the yet-to-be-released work of 2024. Chaika (2023) pays significant attention to the socio-psychological predictors of career decision-making that are critical in forming the career plans of IT specialists. It is valuable to use data collected from coaching to assess the effect of coaching on the development of mentors in professional learning programmes that can be applied in corporate institutions. Zobenko (2020) notes that the use of coaching technologies in training future professionals can be effective, especially in the context of the learning environment.

Lifelong learning, as described by Batsurovska (2023) learning, should incorporate coaching methodologies, especially for engineering personnel to promote flexibility besides strengthening their analytical abilities. Coaching is described as the coaching being an effective learning strategy with the transformative capacities in specific educational and organisational settings; Příloha 2: Bisquerra Alzina (2014). According to Ridai (2024), career coaching proved to be a major need to meet career interest and break existing barriers among Ukrainian IT professionals. According to Zobenko (2020), the logical use of coaching technologies in the formation of qualified future professional, especially those in the field of psychology and pedagogy, can develop competencies needed by professionals. Taken together, these studies provide a picture of how adaptable is coaching as a form of development with respect to the profession and the field of study.

Batunova et al. (2021) focus on online learning for IT professionals to demonstrate how it is possible to modify the coaching approach for online delivery. Zamlynskyi et al. (2021) discuss the effects of human resource management through coaching to determine the effects on the employees' competitiveness. Zamlynskyi et al. (2020) consider the issue from the position of the flow of innovative development, in which coaching is employed to resolve organisational conflicts. According to Purohit et al. (2021), there are factors affecting the graduates' job preferences, and coaching should be included for better results. Thus, analysing the perspectives of career-related learning in the monograph, Lozovetska (2015) also pays considerable attention to the aspects and the significance of using the coaching models of personal career development. However, there is still an issue of low availability of such services for IT specialists because of the lack of knowledge or money. More specifically, the stability and efficacy of coaching approaches in the long term and different organisational and cultural settings need to be investigated.

While the review of the current methodologies presented here has provided authors' insights into the findings, more can be desired given that the approaches borrow from qualitative assessments and normally take small sample sizes. Few attempts are made to analyse the overall role of coaching with respect to business and personal career management. Also, although some researchers point to the effectiveness of coaching in relation to technical aspects, many do not take into account the organisational problems which may include physical and/or financial access. This research seeks to address these gaps to some extent, by using both quantitative data analysis as well as qualitative findings obtained from this study. In turn, it aims to offer the more inclusive account of the nature and purpose of coaching within these IT workers' professional experience.

The presented study's goals are well in line with the existing literature, Kryukova et al. (2023), and Khanetska (2024a) ideas of the strategies for working in the highly unstable environment and the long-term career plans' development. However, this research expands on such findings by incorporating organisational and cultural factors seldom considered in prior research. First, the integration of several coaching approaches enhances the study's relevance and helps to address the problem of a lack of theories that can be utilized in various contexts to implement practicalcoaching models.

Methodology

This work utilized both quantitative and qualitative research methods with a view of approaching the investigation of the role of coaching in the self-actualization of IT specialists holistically. To increase the generalizability of the results and achieve a rich, diverse sample, the study was designed with the following characteristics:

Questionnaire Development and Validation: a number of questions were designed specifically to cater for the main parts of the study, the following: career plan, coaching awareness, working experience, and perceptions on coaching services. While developing the process, the authors conducted assessment of the validated instruments applied in other similar studies and reconciled them to required academic standards. The questionnaire underwent a two-stage validation process: review from an expert and the pilot test. Five experts of the domain scrutinised the questionnaire based on the clarity, relevance and content validity of the test items. Next, a pilot test was also administered with 15 IT professionals to check reliability to remove any unclear or multi-faced items. To confirm their internal consistency, the Cronbach's alpha coefficient was computed which gave an acceptable value of 0.85.

Sampling and Data Collection: the participants in the study came from various organizational roles in IT profession and they were Junior, Middle, Senior IT personnel and Team Lead/Manager. To achieve this, purposive sampling was adopted and respondents comprise of professionals in software development, IT system support and freelancing of various ranks in the industries. The data were collected between June and August 2024 via Google Forms, LinkedIn, Facebook professional groups, and Telegram. Further responses were obtained through a filled in corporate newsletter from the participating IT organizations, thus considering regional diversity. To obtain the truthful responses, the participants' identity was not disclosed.

Data Quality Control: one of the important steps was an A stringently controlled quality of the data collection process. Entries that were left partially or filled in erratically were excluded from the study by tracking responses made by the participants. Self-duplicates were detected based on the unique record numbering and the quality of data used for data cleaning methods was robust. These steps made certain that only positive responses were used in the final analysis.

Statistical Analysis Techniques: quantitative data was analyzed by use of descriptive statistics and inferential statistics. Data analysis was done using the Statistical Package for Social Sciences (SPSS) and the graphs were created using Microsoft Excel. Measures of dispersion involved calculating table frequencies, percentages, and means of the data in order to describe the data. Chi-square tests and ANOVA were used to establish marginal homogeneity and significant differences for the career development variables and the professional levels and influence of coaching. Pearson's correlation test was used to establish the relationship between the career aspirations, the extent of using coaching services and perceived benefits. Also, Tableau was applied to build in-live solutions that helped to analyze crucial insights and trends more interactively.

Comparative and Qualitative Analysis: in order to make the comparison, this study's results were compared with the prior findings, including the studies of Kryukova et al. (2023) and Khanetska (2024). Content analyses of the worked examples of open-ended questions in the questionnaire were done to explore

common themes of perceived barriers and opportunities towards the provision of coaching services in the IT field.

Such an approach of the analysis of research objectives safeguards a comprehensive investigation of the importance of coaching for professional self-fulfillment. Explicitly outlining the research method and the process of operationalizing the variables and the statistical analysis and quality assurance, the study follows research best practices.

Results

The contemporary concept of coaching is one of the primary levers for communication in professional training, including IT specialists, in the context of continuously enhancing adaptability to changes. The main approaches to using coaching include the following aspects:

1. Individual coaching is the most personal solution that relates to the needs of a particular inflicted expert. With the help of 'strengths' and 'areas of improvement', it became possible to define the further evolution strategy of the individual. Its main advantage is the supposedly free choice of instruments and methodologies considering the client's ethical-moral principles and objectives. According to Kryukova et al. (2023), individual coaching can increase professional self-confidence and enhance decision-making competence. With this approach, any qualified IT professionals working in this capacity can be easily trained in new technologies. It also enhances their general employability status in the labour market, thus assuring sustainable employment progress.
2. Team coaching concentrates on enhancing the effectiveness of a team or a group to meet his or her goals. It promotes team members' appreciation of each other, which is valuable given the nature of project activities in the IT sector. According to Vedina et al. (2020), team coaching entails determining the role of each participant in the team, thus eliminating conflict. This applies to teams in the organisation because it leads to better interaction, faster decision making and improved results. Coaching is also applied to the creation of a support system in the organisation, which is helpful in the creation of a practical and desirable working environment. The result of this approach is an improvement in the productivity of the entire team and the satisfaction of the team members from working collectively.
3. Career coaching focuses on the individual's career and overall objective in career life. It assists clients in defining their career objectives and creating a strategic vision with the right strategies. As Khanetska (2024a) highlighted, career coaching involves interest, ability and demand both inside and outside people. This is particularly crucial in the IT organisation due to the fast pace of technological improvement, which demands constant change. Coaching prevents dead-end situations in the workplace and can prepare a person for the transfer to a new, higher level of job responsibility. It also contains resources for successful job search eCommerce, bargaining working conditions, and oneself in the marketplace.
4. IT professionals hoping to become managers or project leaders need leadership development coaching. Its target is developing strategic thinking, emotional intelligence, and motivation. According to Zobenko (2020), leadership coaching is essential to develop team management, decision making and adaptation skills. When coached through this, professionals learn how to spend resources, delegate tasks, and create an environment for good. Coaching also helps develop the ability to find solutions to conflicts and communicate with different personalities. This makes professionals competent in their role to lead in a professional environment.
5. Coaching integration into the educational process prepares future professionals for independent planning and realising professional targets. According to Dzikovska (2019), coaching is a pedagogical technology that promotes critical thinking, independence, and responsibility. Learned education coaching techniques help students grasp who they are and which areas they can develop more. The knowledge of IT allows students to adapt to rapidly changing technologies and employer needs. In addition, coaching is a learning process that develops time management, teamwork, and communication skills. The result is that this approach improves the efficiency of professional training and the competitiveness of graduates in the labour market.

Existing approaches to coaching demonstrate its versatility and effectiveness in the professional development of IT professionals. The choice of a particular approach depends on the development goals, specifics of professional activity, and expected results.

Considering the impact of coaching techniques on forming a career strategy for IT professionals is crucial. *Identification of goals and priorities.* Coaching techniques help IT professionals clearly define their career goals and priorities. Through an in-depth analysis of personal values and professional ambitions, coaching allows clients to realise what skills and knowledge they need to develop. Khanetska (2024b) emphasises that this process contributes to creating a clear career vision that meets both the needs of the professional and the requirements of the market. This allows professionals to focus on the tasks that best contribute to their professional development. It minimises the possibility of taking the incorrect opportunity for a job or a career pathway. This also prevents burnout due to an expectation and reality gap.

Key competences development. Coaching aids in identifying, developing, and nurturing the distinctive professional competences needed for professional growth. IT can include technical soft skills such as communication, leadership, and critical thinking. Kryukova et al. (2023) stress that coaching for changing technological trends allows employees to adapt to changes in the market and be relevant in the labour market. Personalised training, feedback and motivational techniques are used to achieve this. IT professionals are more competent in acquiring degrees and can carry out sophisticated work professionally. Furthermore, competence development enhances their attractiveness in the job market.

One of the most essential advantages of using coaching methods is the ability of specialists to change in the IT sector constantly. This is important because technology is changing quickly, and professionals must be ready. Balakhtar, Bondarchuk, & Kazakova. (2024), Zobenko (2020) notes that coaching promotes the development of flexible thinking and the ability to learn new knowledge and technologies quickly. This gives professionals an advantage when they must respond to uncertainty or change their career path. Adaptability not only helps professionals stay at the current level but also actively move up the career ladder. As a result, it increases their resilience to challenges related to changes in environmental or working conditions.

Improving self-presentation skills. Coaching techniques help IT professionals develop the self-presentation skills necessary for successful employment or career advancement. The professionals learn to effectively present their achievements, demonstrate their strengths, and set expectations. Khanetska (2024b) emphasises that self-presentation skills are critical in today's competitive environment. They help to establish connections with employers, clients and colleagues. In addition, these skills contribute to successful job interviews and building a positive professional image. As a result, IT professionals get more opportunities for career development.

Increasing the level of motivation. Coaching helps to maintain a high level of motivation for IT professionals on the way to achieving their career goals. Professionals receive support and inspiration through regular meetings with a coach to overcome difficulties and achieve their goals. Kryukova et al. (2023) note that motivation is essential to career success. Coaching also allows professionals to understand their internal drivers better and encourages them to develop themselves. This helps not only to achieve current goals but also to develop long-term career strategies. As a result, professionals feel more satisfied with their work and professional path.

The study of the impact of coaching techniques on the professional self-realisation of IT specialists was conducted using a questionnaire. A special questionnaire was developed, which contained questions covering the following aspects: the level of professional experience of the respondents, their career goals, awareness and experience of using coaching services, assessment of the impact of coaching, as well as the primary professional barriers and the most valuable aspects of working with a coach.

The sample included IT professionals from different levels: junior, middle, senior, and executive positions. Respondents working in various IT sectors participated in the survey, which allowed us to obtain representative data. The survey was conducted online using specialised data collection platforms such as Google Forms, which made it easy for respondents from different regions to participate. The main focus was on IT professionals working in software development and IT systems support companies as well as freelancers involved in the IT sector. The questionnaire was distributed through professional social networks such as LinkedIn and specialised groups on Facebook and Telegram targeting the IT community. In addition, several IT companies agreed to participate in the survey and used internal corporate newsletters. More than 126 IT professionals of various professional levels (Junior, Middle, Senior, Team Lead/Manager) participated in the survey. This approach ensured the collection of representative data covering various aspects of the use of coaching services and their impact on career development in IT. The respondents answered anonymously, which helped to increase the accuracy and sincerity of the information provided.

The responses were analysed using quantitative methods, including calculating shares and percentages for each category of responses. The study also included comparing the impact of coaching on various career aspects, such as planning, technical and soft skills development, motivation, and stress management. In addition, information was gathered on the main obstacles IT professionals face and expectations regarding implementing coaching services in organisations.
Let us graphically analyse and present the data (Figures 1-7).

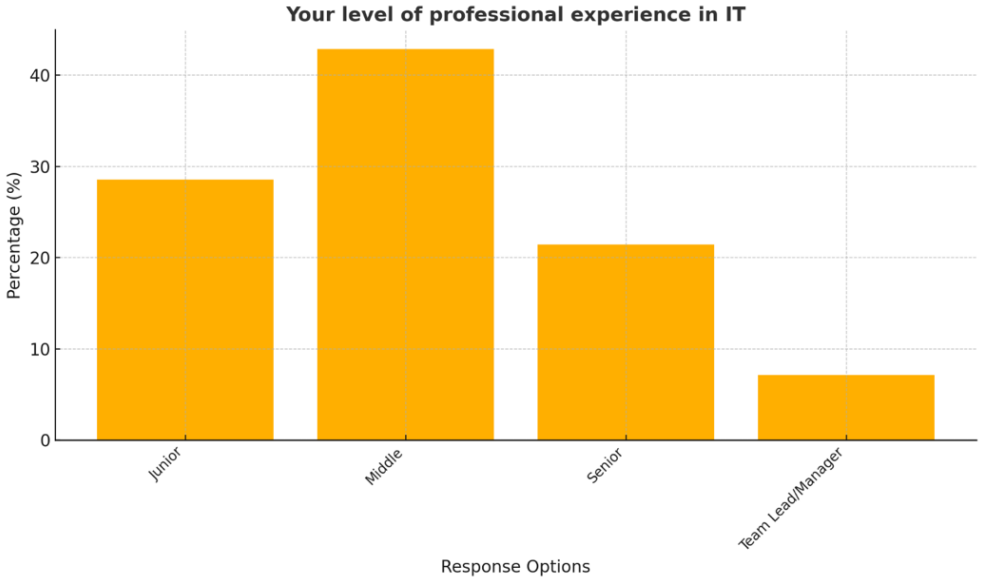

Figure 1. Results of the survey of IT specialists on the impact of coaching on their professional self-realisation.

The survey showed that the largest share of IT professionals belongs to the Middle level (42.86%), while only 7.14% hold managerial positions. Among the professional goals, the most frequently mentioned was the development of technical skills (51.43%), which significantly exceeds other goals, such as changing specialisation (14.29%). Coaching is familiar to 68.57% of respondents, but only 41.43% have used these services. The most significant impact of coaching is increased confidence (52.14%) and improved career planning (31.43%). The main obstacles to achieving career goals include lack of technical skills (36.43%) and lack of support from the employer (31.43%). The most crucial aspect of working with a coach is career planning (49.29%), while 71.43% of respondents noted a significant or moderate impact of coaching on their development. These data indicate the significant role of coaching in shaping the professional strategy of IT professionals.

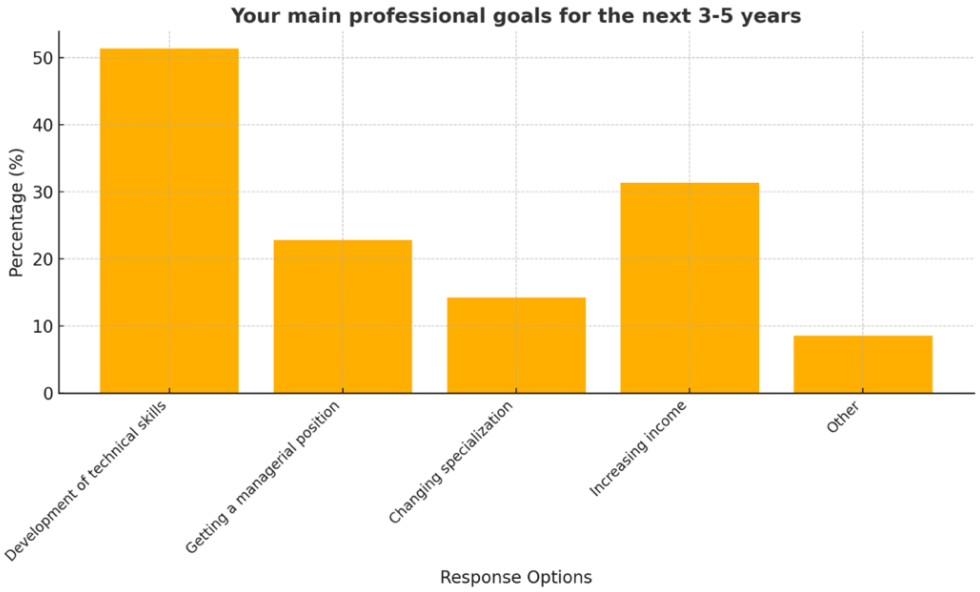

Figure 2. Analysis of barriers and needs of IT professionals in career development.

Among the main obstacles to achieving career goals, IT professionals most often mentioned a lack of technical skills (36.43%) and a lack of support from their employer (31.43%), which is significantly higher than the share of respondents who noted low self-esteem (27.14%) or lack of a career plan (18.57%). As for the aspects of working with a coach, the most useful are career planning (49.29%), motivation and stress management (45.00%), and soft skills development (38.57%). Only 11.57% of respondents mentioned other aspects. In addition, 61.43% of respondents consider it advisable to introduce coaching services in their organisation, in particular for developing a career plan (47.14%) and improving professional skills (32.86%). Time management training is less popular (20.00%). The data shows that technical and soft skills remain critical areas for improvement, while employer support is a significant factor for successful career development.

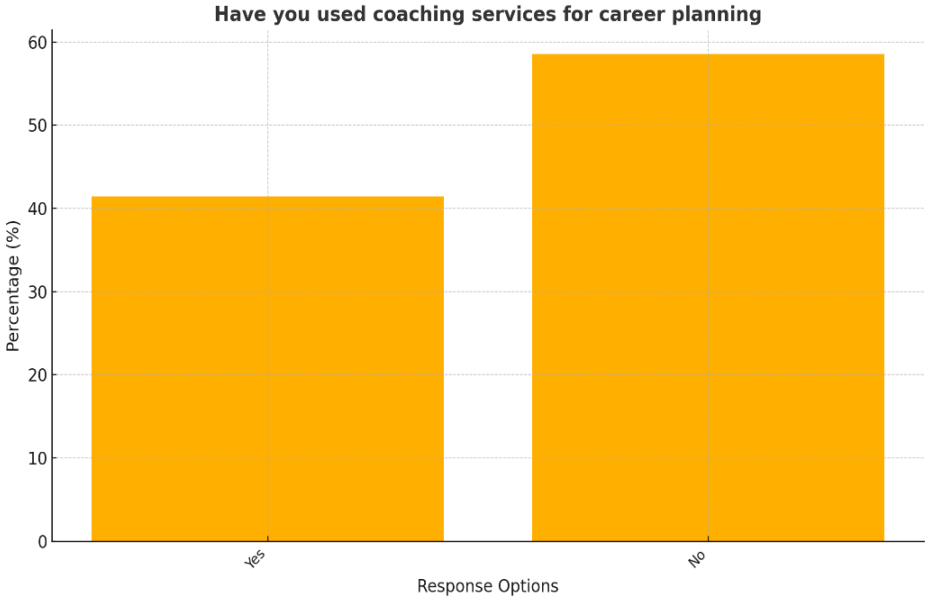

Figure 3. Use of coaching services for career planning among IT professionals.

The data shows that most respondents (58.57%) have not used coaching services for career planning, while only 41.43% have. This gap of almost 17% indicates that a significant proportion of IT professionals do not seek coaching, possibly due to a lack of access or awareness. More than 40% of coaching service users indicate a demand for such services in the IT sector. It is worth noting that this indicator is essential for analysing the effectiveness of coaching and its impact on career development. The results also indicate the potential for broader implementation of coaching aimed at developing career strategies. This analysis can help IT organisations develop appropriate employee support programmes.

Most respondents assessed the impact of coaching on their career strategy as moderate (39.29%) or significant (32.14%), which makes up 71.43% of the respondents. Only 17.86% reported a minimal impact, while 10.71% felt no effect. It is noticeable that the positive impact of coaching prevails, demonstrating its value in professional development. The smallest percentage of respondents in the "No impact" category indicates that it is rare for coaching to be of no benefit. These data underline that coaching programmes should be integrated into the corporate culture to enhance the professional development of specialists. However, the existence of categories with minimal or no impact indicates the need to optimise coaching methods and consider individual needs.

The most significant obstacle to achieving career goals was the lack of technical skills (36.43%). Lack of employer support is the second most crucial problem, which 31.43% of respondents mentioned. Low self-esteem was mentioned by 27.14% of participants, while the lack of a clear career plan was a problem for 18.57% of respondents. Other obstacles accounted for the smallest share of 13.43%. The analysis shows that technical and organisational aspects remain the main challenges for IT professionals. This data underlines the importance of developing technical competences and creating a supportive work environment with clear career opportunities.

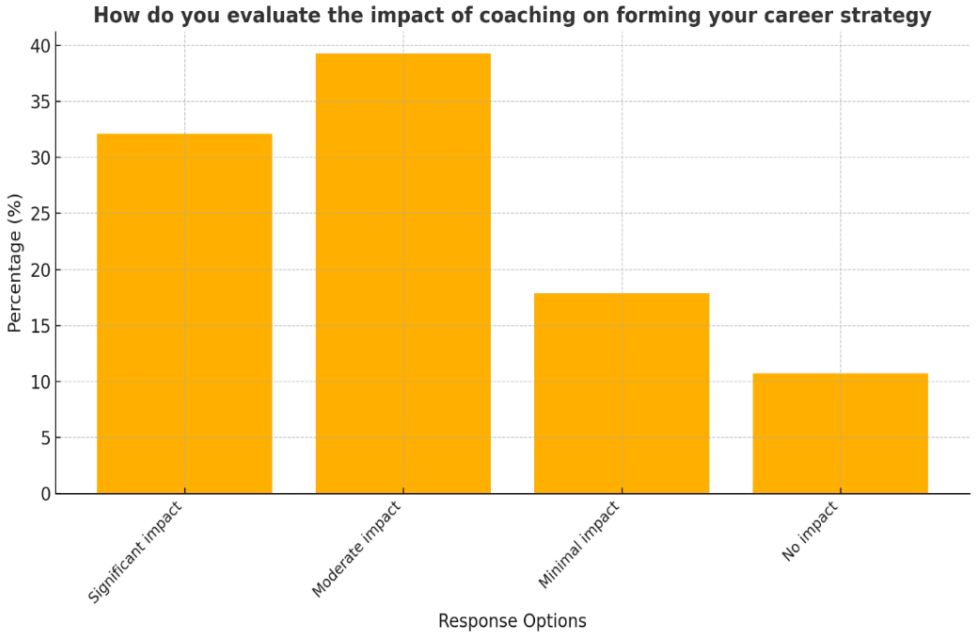

Figure 4. Evaluation of the impact of coaching on the formation of a career strategy for IT professionals.

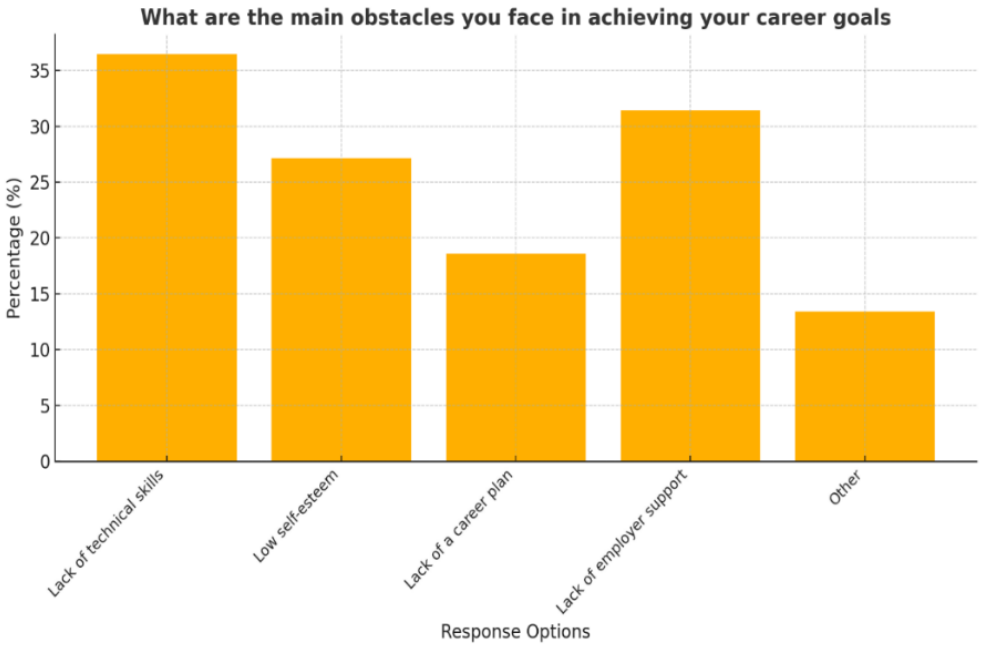

Figure 5. The main obstacles to achieving career goals of IT professionals"

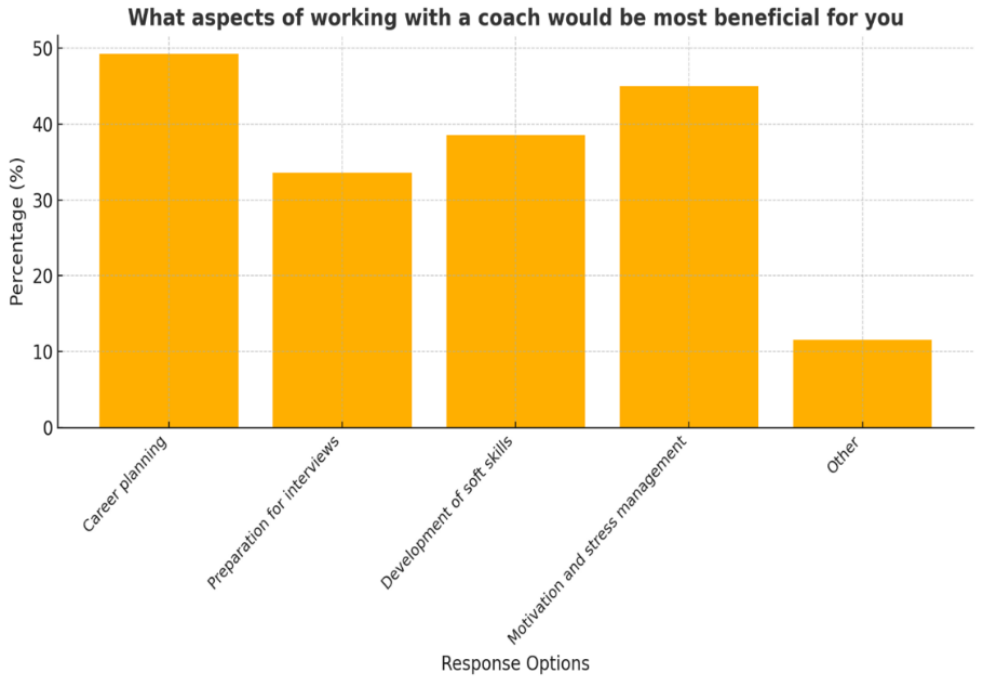

Figure 6. The most valuable aspects of working with a coach for IT professionals.

The most helpful aspect of working with a coach was career planning, which received 49.29% of the vote. Motivation and stress management came in second with 45.00%. Developing soft skills was essential to 38.57% of the survey participants while preparing for interviews garnered 33.57%. Only 11.57% of respondents chose other aspects. These data indicate that career planning is a crucial need among IT professionals, and psychological support and soft skills development play an essential role in their

professional growth. The relatively low interest in preparing for interviews may indicate that respondents are more interested in long-term strategies than in one-off events.

Figure 7. Feasibility of implementing coaching services in IT organisations.

Most respondents (61.43%) consider introducing coaching services in their organisation appropriate, while 38.57% share the opposite opinion. This more than 22% gap indicates a significant interest in such services among IT professionals. Positive responses indicate an awareness of the benefits of coaching, such as skill development and career support. At the same time, the share of negative responses indicates a certain amount of scepticism or lack of awareness of the effectiveness of coaching. These findings highlight the importance of promoting coaching techniques and developing programmes considering employees' needs. The introduction of coaching can be a vital tool for increasing staff motivation and efficiency.

Table 1.
The main factors of successful professional self-realisation of IT specialists

Factor	Meaning	Research/Example	Recommendations
Technical competence	A high level of technical skills is the basis for career growth.	Gadatsch (2023): Developing modern technical skills ensures competitiveness in the labour market.	Continuous training, certification, and participation in professional training.
Soft Skills	Communication, teamwork, leadership, and critical thinking are vital skills for collaboration in the IT environment.	Vedina et al. (2020): Soft skills development promotes effective interaction in team projects.	Integrate soft skills training into the professional programmes of IT companies.
Motivation and goals	Clearly defined career goals and high internal motivation contribute to rapid development.	Khanetska (2024b): Professionals with clear plans achieve higher levels of job satisfaction.	Use coaching to identify and adjust career plans.
Working environment	A friendly corporate culture, flexibility and support for development contribute to self-realisation.	Kryukova et al. (2023): Investing in staff training increases talent retention.	Create corporate mentoring and coaching programmes and provide opportunities for professional development.

Continuous training	Continuous improvement of skills and knowledge through courses, training, and certifications is essential to remain competitive.	Dzikovska (2019): Curricula with coaching contribute to developing professional competences.	Support employees' participation in training courses, such as Coursera, Udemy, or specialised training.
Mentoring and coaching	Mentoring helps to navigate difficult professional situations and identify the best ways to develop.	Merrill et al. (2023): Coaching increases confidence in decision-making.	Implement corporate coaching and mentoring programmes for employees at all levels.

Source: developed by the author based on survey data (Khanetska, 2024 b) and analysis (Merrill et al., 2023).

Discussion

The study found a significant impact of coaching on the professional self-realisation of IT professionals, which is confirmed by the survey data. According to the research of Kryukova et al. (2023), this is consistent with the fact that coaching is crucial for the development of such critical competences as technical and soft skills. Although most respondents (71.43 per cent) expressed a positive impact of coaching, a share of professionals (17.86 per cent) responded that there was no or little impact. This may be explained by both the implementation weaknesses of coaching programmes and the absence of an individual approach to the needs of employees.

The data on the importance of technical skills for career advancement (36.43%) supports the findings of Gadatsch (2023), who emphasises the need to continuously improve technical competence to maintain competitiveness in the labour market. At the same time, the lack of employer support (31.43%) is consistent with the findings of Vedina et al. (2020), which point to the importance of creating a favourable working environment. Particular attention is drawn to the difference in the use of coaching services: only 41.43% of respondents used them, despite the awareness of 68.57% of professionals. This gap indicates the need to increase the popularisation of coaching techniques. Khanetska (2024 a) notes that career coaching should facilitate adaptation to changing market conditions, but the study results show that some IT professionals remain outside these opportunities.

The findings on career planning as a critical aspect of coaching (49.29%) are consistent with Khanetska (2024b), who emphasises the importance of a long-term career vision. At the same time, soft skills development (38.57%) highlights a multidimensional one and soft skills training is needed in corporate programmes. Zobenko's (2020) findings also point to the vital lesson of adaptability to change. However, while most of it passes with flying colours, some limitations exist. Specifically, it also needs employers to support it and the lack of awareness of the benefits of coaching. However, more research is needed to develop optimal models for the implementation of coaching services.

Overall, the study's results indicate that significant possibilities exist for using coaching as an instrument for the professional self-realisation of IT professionals. Future research should attempt to explore the details of coaching implementation in different contexts and assess the long-term impact of coaching on adaptation to technological changes.

Conclusions

The study demonstrates a significant service of coaching to the professional self-realisation of IT specialists in the face of rapid changes in the labour market. The literature finds that coaching can provide input in building career strategies, building critical competences, and stimulating employees' motivation. The obtained results are novel in establishing a relationship between the type of coaching (individual, team, career) and the professional development level of IT specialists. It facilitates the transformation of the coaching technique to fit specialist needs, thus promoting the working efficiency of such techniques. The study's practical significance lies in the possibility of using its results to develop corporate coaching

programmes that will help increase the productivity and competitiveness of IT companies. The results may also be helpful for educational institutions that train future IT professionals. Among the study's limitations is the lack of a sufficiently broad geographical coverage of the sample, which may affect the representativeness of the results. In addition, the limited number of aspects of coaching studied indicates the need for further analysis expansion. The study results indicate the potential of coaching for solving IT specialists' professional development problems. However, further research should focus on assessing the long-term effects of coaching and its adaptation to different industries and cultural contexts. Implementing corporate coaching programmes focusing on developing technical and soft skills, as well as maintaining employee motivation and adaptability to technological change, is recommended. The main directions for further research include analysing the effectiveness of coaching in the context of interdisciplinary cooperation and assessing its impact on the emotional intelligence of specialists.

Bibliographic references

Balakhtar, V., Bondarchuk, O., & Kazakova, S. (2024). Career crafting literature meta-review. *Multidisciplinary Science Journal*, *6*. https://doi.org/10.31893/multiscience.2024ss0741

Batsurovska, I. (2023). Education of energy engineers in the context of lifelong learning. *Proceedings of the 4th International Conference on History, Theory, and Methodology of Learning*, Kryvyi Rih, Ukraine, October 12-13, 2023, 5-12. https://www.scitepress.org/Papers/2023/126455/126455.pdf

Batunova, I. V., Lobyneva, E. I., Nikolaeva, A. Y., & Baturina, N. V. (2021). Teaching IT specialists with the help of online learning. In *E. G. Popkova, V. N. Ostrovskaya, & A. V. Bogoviz (Eds.), Socio-economic systems: Paradigms for the future (Studies in Systems, Decision and Control, Vol. 314, pp. [insert page range if available]).* Springer, Cham. https://doi.org/10.1007/978-3-030-56433-9_114

Bisquerra Alzina, R. (2014). Coaching: Un reto para los orientadores. *Revista Española de Orientación y Psicopedagogía*, *19*(2), 163-163. https://doi.org/10.5944/reop.vol.19.num.2.2008.11423

Chaika, R. (2024). A literature review on consulting self-efficacy in career decision-making. *Scientific Perspectives*, *3*(45), 1319-1326. https://doi.org/10.52058/2708-7530-2024-3(45)-1319-1326

Chaika, R. M. (2023). Socio-psychological predictors of the career decisions of Ukrainian IT specialists during the war. *Habitus*, *(45)*, 206-213. https://doi.org/10.32782/2663-5208.2023.45.34

Chayka, R., & Zelenin, V. (2024). Exploring the relationship between personality and subjective career success: A study of the Big Five traits among Ukrainian IT specialists. *Conhecimento & Diversidade*, *16*(41). https://doi.org/10.18316/rcd.v16i41.11504

Dzikovska, M. (2019). Coaching as the pedagogical technology in professional training of future specialists. *New Professional Education: Theory and Practice*, *(3)*, 45-50. https://doi.org/10.28925/1609-8595.2019.3.4550

Gadatsch, A. (2023). IT support for process management. In *Business process management* (pp. [insert page range if available]). Springer, Wiesbaden. https://doi.org/10.1007/978-3-658-41584-6_6

Iswarya, V. S., Babima, M., Muhila, M. G., & Others. (2024). Enhancing well-being: Evaluating the impact of stress management interventions for IT professionals in the workplace. *International Journal of System Assurance Engineering and Management*, *15*, 3318-3336. https://doi.org/10.1007/s13198-024-02339-2

Khanetska, T. (2024a). Factors influencing workplace choice among Ukrainian IT specialists. *Prospects and innovations in science*, *3*(37), 1026-1034. https://doi.org/10.52058/2786-4952-2024-3(37)-1026-1034

Khanetska, T. (2024b). Career calling - A new concept in psychology. *Scientific Perspectives*, *3*(45), 1307-1318. https://doi.org/10.52058/2708-7530-2024-3(45)-1307-1318

Kryukova, I., Zamlynskyi, V., Zamlynska, O., Skrypnyk, N., Reznik, N., & Moussa, C. B. (2023). Coaching as a tool for adaptive personnel management of modern companies. In B. Alareeni & A. Hamdan (Eds.), *Explore business, technology opportunities and challenges after the Covid-19 pandemic. ICBT 2022* (Lecture Notes in Networks and Systems, Vol. 495, pp. 359-368). Springer, Cham. https://doi.org/10.1007/978-3-031-08954-1_26

Lozovetska, V. T. (2015). *Professional career of a person in modern conditions*. Kyiv. Retrieved from: https://core.ac.uk/download/pdf/32310612.pdf

Lozovetska, V., Pavlov, Y., & Fedorenko, L. (2024). Meaningful work literature meta-review. *Multidisciplinary Science Journal*, *6*. https://doi.org/10.31893/multiscience.2024ss0740

Merrill, A. L., Stein, S. L., Chu, J. T., Sarode, A. L., McKinley, S. K., Parangi, S., ... Palamara, K. (2023). Do resident coaching programmes benefit their coaches? Impact of a professional development coaching programme on the coaches. *World Journal of Surgery*, *47*(7), 1609-1616. https://doi.org/10.1007/s00268-023-06957-y

Moura, A. O. R., & Silva, L. C. O. (2019). Work centrality, goals and professional fulfilment: Intersections between work and career. *RAM. Revista de Administração Mackenzie*, *20*(1). https://doi.org/10.1590/1678-6971/eramg190087

Patti, J., Holzer, A. A., Stern, R., & Brackett, M. A. (2012). Personal, professional coaching. *Journal of Leadership Education*, *11*(1), 263-274. https://doi.org/10.12806/v11/i1/ab4

Purohit, D., Jayswal, M., & Muduli, A. (2021). Factors influencing graduate job choice - A systematic literature review. *European Journal of Training and Development*, *45*(4/5), 381-401. https://www.emerald.com/insight/content/doi/10.1108/ejtd-06-2020-0101/full/html

Ridai, N. M. (2024). Factors influencing career choice among Ukrainian IT specialists. *Psychological studies*, *(1)*, 150-154. https://doi.org/10.32782/psych.studies/2024.1.20

Vedina, Yu. Yu., Sakun, L. M., Riznichenko, L. V., & Kovalenko, M. P. (2020). Team and individual coaching as a technology for strategic management of the organisation. *Economics and management organization*, *3*(39), 41-51. https://doi.org/10.31558/2307-2318.2020.3.4

Zaharopoulos, T. (2024). Professional development in international higher education. In *P. Pelonis & T. Zaharopoulos (Eds.), Igniting excellence in faculty development at international schools (pp. [insert page range if available]).* Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-67055-8_16

Zamlynskyi, V., Livinskyi, A., Zakharkiv, I., & Korneeva, T. (2021). Current developments in human resources management. In *Knowledge management competence for achieving competitive advantage of professional growth and development: Collective monograph* (pp. 252-265). BA School of Business and Finance. Retrieved from: http://dspace.kntu.kr.ua/jspui/handle/123456789/10569

Zamlynskyi, V., Stanislavyk, O., Halytskyi, O., Korzh, M., & Reznik, N. (2020). Conflict dynamic model of innovative development in the system of ensuring competitiveness of enterprises. *International Journal of Scientific and Technology Research*, *9*(2), 5322-5325. Retrieved from: http://lib.osau.edu.ua/jspui/handle/123456789/1998

Zobenko, N. A. (2020). Introduction of coaching technologies in the professional training of future specialists in the psychological and pedagogical sphere. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, (*1*(11)), 199-204. https://acortar.link/wlwKuw

Check for updates

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.18

Cómo citar:
Chovriy, S., Marieiev, D., Tsymbal-Slatvinska, S., Vytrykhovska, O., & Tsybulko, A. (2024). Impact of digital technologies on the quality of higher education. *Revista Eduweb*, *18*(4), 265-285. https://doi.org/10.46502/issn.1856-7576/2024.18.04.18

Impact of digital technologies on the quality of higher education

Impacto de las tecnologías digitales en la calidad de la educación superior

Sofiya Chovriy
https://orcid.org/0000-0001-9271-004X
csoori.zsofia@gmail.com
WoS Researcher ID: JFK-9632-2023
Candidate of Pedagogical Sciences, Associate Professor, Associate Professor at the Department of Pedagogy, Psychology, Primary, Pre-School Education and Management of Educational Institutions, Ferenc Rakoczi II Transcarpathian Hungarian College of Higher Education, Ukraine.

Dmytro Marieiev
https://orcid.org/0000-0002-6282-8052
damar_dim@ukr.net
WoS Researcher ID: AAE-6230-2021
Ph.D. in Philology, Associate Professor, Head of the Chair of Foreign Languages and Teaching Methods, Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Ukraine.

Svitlana Tsymbal-Slatvinska
https://orcid.org/0000-0002-2732-5716
lanatsimbal@gmail.com
WoS Researcher ID: G-1216-2018
Doctor of Pedagogical Sciences, Professor, Professor of Special and Inclusive Education Department, Pavlo Tychyna Uman State Pedagogical University, Ukraine.

Oksana Vytrykhovska
https://orcid.org/0000-0003-3669-3382
vytrykhovska@gmail.com
WoS Researcher ID: GYU-0330-2022
Candidate of Pedagogical Sciences, Associate Professor of Department of Social Work and Rehabilitation, National University of Life and Environmental Sciences of Ukraine, Ukraine.

Anna Tsybulko
https://orcid.org/0000-0002-0267-1655
airet11wind@gmail.com
WoS Researcher ID: LOS-1206-2024
Trainee Teacher in the Department of Special and Inclusive Education, PhD Student in the Department of Pedagogy and Educational Management, Pavlo Tychyna Uman State Pedagogical University, Ukraine.

Recibido: 28/10/24
Aceptado: 23/12/24

Abstract

The content of the concept of "digital technologies" is presented. Their classification is proposed, which is effective in the formation of students' professional competencies and indicates the importance of digital technologies in the training of students, contributes to the ability to solve educational tasks independently, and creates the possibility of active individual activity in the modern digital world. The impact of digital technologies

on the quality of higher education is shown. The tasks of digitalization set for a higher education institution are analyzed; the principles and conditions for the formation of a digital environment of a higher school that affect the quality of higher education and the general strategic goals of the development of the educational system are revealed. The general strategic goals of the development of the educational system are taken into account when solving the problem of using digital technologies for high-quality higher education. The importance of virtual reality technology is shown, and virtual modeling and electronic immersive learning technologies for high-quality higher education in the educational space are revealed. The importance of the digital university is shown as a requirement of an innovative modern digital educational space. A system for forming a specialist's digital competence is proposed. Analysis of data obtained during the sections of the formative stage of work recorded the dynamics.

Keywords: digital technologies, quality of higher education, virtual reality technologies, virtual modeling, digital university.

Resumen

Se presenta el contenido del concepto de "tecnologías digitales" y se propone su clasificación, que es efectiva en la formación de competencias profesionales de los estudiantes e indica la importancia de las tecnologías digitales en la preparación de los estudiantes, promueve la capacidad de resolver de forma independiente tareas educativas, crea la posibilidad de una actividad personal activa en el mundo digital moderno. Se muestra la influencia de las tecnologías digitales en la calidad de la educación superior. Se analizaron las tareas de digitalización que tiene ante sí la institución de educación superior; Se revelan los principios y condiciones de la formación del entorno digital de la escuela superior, que inciden en la calidad de la educación superior y los objetivos estratégicos generales del desarrollo del sistema educativo. Los objetivos estratégicos generales del desarrollo del sistema educativo se tienen en cuenta al resolver el problema del uso de tecnologías digitales para la educación superior de alta calidad. Se muestra la importancia de la tecnología de realidad virtual, se revela la simulación virtual, las tecnologías de aprendizaje por inmersión electrónica para una educación superior de alta calidad en el espacio educativo. Se muestra la importancia de una universidad digital como requisito de un espacio educativo digital moderno e innovador. Se propone un sistema de formación de la competencia digital de un especialista. El análisis de los datos obtenidos durante los tramos de la etapa formativa del trabajo registró la dinámica.

Palabras clave: tecnologías digitales, calidad de la educación superior, tecnologías de realidad virtual, simulación virtual, universidad digital.

Introduction

Global trends in the development of both education and management of educational institutions are aimed at transitioning to digital transformation. This means that all educational, scientific, administrative, and other processes of a higher education institution must completely transition to a digital environment. Without digital transformation, a higher education institution cannot effectively organize high-quality educational processes and remote work of its departments with documents and cannot function normally in competitive conditions, which negatively affects students, teachers, and employees (Koval-Mazyuta et al., 2023).

Traditional approaches to automating the activities of a higher education institution have lost their effectiveness and can no longer meet modern requirements. Automated systems of learning, management, and accounting not only do not solve all the tasks of a higher education institution, but they also divide the information space by those functional tasks for the solution of which this or that information is required. Usually, these are separate tools that are not combined into a single system for solving the functional tasks of a higher education institution. And, of course, such an approach does not allow for the effective implementation of digitalization projects and does not allow for the creation of a single system for building digital universities. New approaches and new concepts of digital transformation of higher education institutions are needed. Approaches that will allow for the unification of all processes of creating and using software and information tools for the construction of digital universities (Kovalskyi & Kyslenko, 2024).

Therefore, an urgent scientific task arises, which is to develop methods and models of digitalization of higher education institutions based on the unification of all functions, procedures, and information bases into a single concentric information technology for the digital transformation of educational activities of a higher education institution (Karpliuk, 2017).

The development of digital technologies in the high-quality training of future specialists is currently a relevant issue of the theory and methodology of teaching in the educational process. Based on this, we considered the following issues in the article:'

- The content of the concept of "digital technologies" and their classification.
- The impact of digital technologies on the quality of higher education.
- Digitalization tasks are set for higher education institutions.
- Principles and conditions for the formation of a digital environment of a higher education institution that affects the quality of higher education and the general strategic goals of the development of the educational system.
- Taking into account the general strategic goals of the development of the educational system when solving the problem of using digital technologies for high-quality higher education.
- Virtual reality technologies and virtual modeling, electronic immersive learning technologies for high-quality higher education in the educational space.
- A digital university is a requirement of an innovative, modern digital educational space.

Therefore, the relevance and insufficient development of the issues of the theory and practice of the impact of digital technologies on the quality of higher education determined the choice of the topic of the article.

Literature Review

In the global scientific debate, scientists have made several positive changes in the development of digital technologies and the digital competence of specialists, but the process of influencing digital technologies on the quality of higher education requires improvement and optimization.

The analysis of scientific publications and research, the identification of the main trends in the development of digital education, and the study of existing practices in this area were analyzed by A. Gedzyk (2024). The results of the study include an analysis of massive open online courses, a review of the evolution of distance learning, an identification of the advantages of such technologies and the challenges of their use, and examples of successful implementation in higher education are also provided.

In connection with the integration of digital technologies into all modern fields of science, technology, and professional human activity, V. Kovalsky & D. Kyslenko (2024) analyzed the pedagogical aspects of the use of digital technologies in higher education; key terms were defined, changes occurring in pedagogical practice were considered; drew attention to the analysis of the role of adaptability of digital resources and mobility, which contributes to the involvement of students in innovative activities and greater flexibility of teaching methods in the educational process.

Thus, the authors' works highlight the resources used in teaching: multimedia platforms, social networks, learning management systems (Google Classroom, Moodle), artificial intelligence algorithms that allow adjusting educational content according to the individual needs of each student, the use of game elements in teaching, which stimulates the active participation of students in the educational process.

The features of virtual reality are considered by A. Ulishchenko & V. Ulishchenko (2022), which is the basis for teaching students of higher educational institutions to use and develop IVR technologies. An overview of several VR platforms is offered, and attention is also focused on various aspects of organizing online teaching. It has been proven that the use of 360° visualization offered on various Internet resources allows you to create an immersion effect in the communicative environment when learning a language and contributes to the improvement and acquisition of practical communication skills. Continuing the authors'

opinion, O. Tovkanets (2018) considers the main strategic aspects of the development of digital technologies in European higher education. Documents on the problems of the Council of Europe strategy are analyzed. To ensure the competitiveness of future specialists, competencies, and professional knowledge to contribute to innovation for successful entry into the European labor market, ways of implementing digital technologies at the international and national levels have been identified. An attempt to analyze the modern definition of "digitization" of the information society was made by S. Karplyuk (2019). Thus, several authors' data reveal the process of digitalization and informatization of modern spheres of human activity. The main directions and results of the digital revolution are outlined. It is proven that the digitalization of education directly depends on the degree of mastery of digital technologies of higher education teachers and the level of digital literacy of students. The main tasks of each higher education institution regarding the digitalization of its activities are determined.

Having analyzed the works of the authors, we note that the researchers paid attention to the analysis of the role of adaptability of digital resources and mobility, which contributes to the involvement of students in innovative activities and greater flexibility of teaching methods in the educational process. The tools used in teaching were considered: multimedia platforms, social networks, learning management systems (Google Classroom, Moodle), and artificial intelligence algorithms, which allow adjusting educational content to the individual needs of each student. It is proven that the digitalization of education directly depends on the degree of mastery of digital technologies of higher education teachers and the level of digital literacy of students.

According to the results of studying the works of scientists, it was found that the problem of the impact of digital technologies on the quality of higher education was not the subject of separate special studies. The need to study and solve the specified problem and its relevance is due to the existing contradictions between:

- Modern requirements for the organization of the educational process of students, and insufficient justification of the conceptual, didactic, and methodological foundations of the formation of digital competence of education seekers;
- The needs of society in future specialists with a high level of formation of digital competence and the real state of students' training;
- The didactic potential of modern education in the formation of digital competence of students in the educational environment and the lack of certain substantiated didactic conditions, the creation of which will contribute to the effectiveness of the implementation of this process.

Therefore, a conceptual study of this problem will allow designing digital technologies in higher education institutions that will contribute to ensuring high-quality training of specialists in the conditions of a digital society.

The purpose of the article is to show the influence of digital technologies on the quality of higher education to analyze the pedagogical aspects of the use of digital technologies in higher education.

Methodology

Research methods are based on general scientific and systemic approaches that are focused on studying terminology, specifics of functioning, and cognitive perspectives of the problem.

The study uses theoretical research methods (generalization of publications, analysis of the source base, software options) and empirical research methods (observation of the educational process in higher education, student audience, questionnaires, surveys); methods of statistical and mathematical data processing to clarify the reliability of the quantitative and qualitative analysis of the results of the experiment (Fisher's angular transformation).

In our case, the state of the subjects at the beginning and the end of the experiment was considered. A comparison was made according to the frequency of the studied indicators (generalized indicators; the level of formation of each of the components). The conversion into the values of the central angle of the percentages, given in radians, is the Fisher angular transformation φ. A larger percentage corresponds to a larger angle $\varphi 1$ and a smaller angle $\varphi 2$ to a smaller one. It should be noted that the relationship between these values is nonlinear: $\varphi = 2arcc\overline{i}n\sqrt{P}$, (1), where P is the percentage expressed in fractions of a unit. The values of the criterion increase with an increase in the number of samples or an increase in the angles of divergence. The existing differences between the samples are non-random, the more likely, the larger the value of φ.

The study had the following statistical hypotheses:

- H0: the level of formation at the end of the experiment of the corresponding indicator is not higher than at the beginning of the experiment;
- H1: the level of formation at the end of the experiment of the corresponding indicator is higher than at the beginning of our experiment.

As a result of our work, a pedagogical experiment was conducted, which took place within the framework of the annual program.

To determine the level of formation of a specialist's digital competence, surveys were conducted among students divided into CG and EG regarding the formed skills of working with digital tools and existing knowledge that emphasize digital competence.

The summarized results of the initial levels of formation of digital competence of specialists of EG and CG at the ascertaining stage of the study indicate the need to develop a system for the formation of a specialist's digital competence, introduce changes, implement and search for effective methods, forms, and means of forming the digital competence of a future specialist.

Therefore, the implementation of the system for the formation of a specialist's digital competence involved conducting a formative stage of the experiment.

Based on the research, we developed a system for the digital competence of a specialist.

We took into account the fact that the answers to the questions reflect the most accurate picture of the specialist's digital competence, and it is the answers to the questions that are required of users and are based on the results of performing innovative tasks, we formed levels based on the results, not through self-assessment.

To conduct a statistical analysis at the beginning of the experiment and at the time of its completion, we compared the state of the group. Fisher's angular transformation was used. The effectiveness of the developed system for forming a specialist's digital competence is evidenced by the obtained indicators.
The effectiveness and efficiency of training were checked using the consumer loyalty index – NPS and key performance indicators – business indicators KPI, which are universal.

To assess the quality of the training organization, we used the NPS (Net Promoter Score) consumer loyalty index. Respondents were classified by their degree of readiness to recommend the digital competence formation system (training, methodology) to other people using questions.

When receiving the NPS index, we made the following conclusions:

- An index of more than 50% indicates high results, where the respondent is noted as a leader in the labor market with a high level of digital competence formation using the system for the formation of a specialist's digital competence;

- From 30% to 50%, the index indicates a good result of the formation of the level of digital competence using the system for the formation of a specialist's digital competence. However, we took into account that a series of errors or a negative incident can affect the reputation of the organizer of the system for the formation of a specialist's digital competence;
- Up to 30%, the index indicates the presence of minor problems in the formation of the level of digital competence using the system for the formation of a specialist's digital competence, which requires attention to all structural divisions that conduct direct training;
- Less than 0% – a negative index, which indicates that the number of respondents dissatisfied with the system for forming the digital competence of a specialist significantly exceeds the number of satisfied respondents and is a systemic problem.

The NPS index we obtained = 48, which indicates a high-quality organization of training in general and indicates a high-quality experiment, a correctly chosen tactic, and a strategy for building a training system, which is based on the effective formation of digital competence of respondents using the developed system. Since the respondents who are studying will be competitors in the services market, we assessed the results of the experimental work using the Key Performance Indicators (KPI) indicator.

Key performance indicators are KPIs used to assess the achievement of goals and their clear reflection or optimality of the process and are measured in numbers, as well as achieving efficiency and effectiveness of the process. An important management tool is key performance indicators, which allow you to evaluate and control the work of departments, working groups, individual specialists, and companies. KPI analysis contributed to the assessment of the implementation of the selected strategy for forming the digital competence of a specialist. In our study, the indicators were:

- KPI – the ratio of respondents who successfully completed their training and the formation of their digital competence corresponds to a high level;
- KPI-2/1, KPI-3/1, KPI-3/2 – the ratio of respondents who joined the number of participants of the previous level – to the next level. During the basic level of the training course, an experiment was conducted in which we analyzed the dynamics of the results obtained in the context of each of the levels;
- More than 75% of students successfully completed the basic level of training, which for a mass course is a very high indicator of the formation of their digital competence (the indicator fluctuates within 10-25%);
- 82% of respondents passed the average level of training;
- 72% of respondents passed the advanced level of the course (data according to the KPI indicator).

Other indicators (KPI-2/1, KPI-3/2, KPI-3/1) indicate that after completing the training on the developed system for the formation of digital competence of specialists of the full-fledged basic level course, we managed to keep the attention of respondents who joined the advanced level of the course and the intermediate level of the course. More than 20% of respondents successfully completed the three levels of training on the developed system for the formation of digital competence of specialists.

We note that there were no requirements for mandatory training at all levels because the material of the basic course already allowed respondents to effectively use the proposed digital tools in their professional activities, which was provided to them by the developed system for the formation of digital competence of specialists.

The analysis of data obtained during the sections of the formative stage of work recorded the dynamics.

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

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

At the main stage, the experiment was conducted.

At the third, 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 results obtained and the objectivity of their assessment were ensured by the methodological soundness 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.

The study largely depends on the accuracy and reliability of the data. In research, the quality of data collection and analysis not only adds weight to the research but also contributes to the formation of sound conclusions, which is key to academic success.

The following digital tools for data collection were useful in the study: Microsoft Excel or Google Sheets - spreadsheets are useful for organizing and analyzing collected data when working with quantitative data. The total sample size was 86 subjects. The sample was formed by random selection using the technical procedure of calculating the selection step.

The results of the experimental study confirmed the applicability, optimality, and effectiveness of the proposed ways of the impact of digital technologies on the quality of higher education.

Results and Discussion

The content of the concept of "digital technologies" and their classification.

The educational environment in which learning takes place is significantly affected by the adaptability of digital technologies and mobility. It is such an educational environment that acts as a tool for adaptation and personal flexibility to changed forms of educational interaction of the individual, characterized by the absence of temporal, geographical, and territorial restrictions and high dynamism of the educational process. The development of the educational environment is closely related to the use of modern digital innovative technologies.

The wide application of the concept of "digital technologies" in the process of analyzing international regulatory legal acts at the world level has been revealed. M. Zhurba (2013) describes digital technologies as technologies where information is encoded into discrete signal pulses. O. Bernazyuk (2017) refers to the concept of "digital technologies" as technologies that use digital signals to transmit information.

Scientific research proves that it is important for education that publishing and technology companies, together with professional associations, actively stimulate and support the efforts of higher education teachers in implementing digital technologies for continuous innovative improvement of the educational process (Mytnyk et al., 2024). This approach contributes to the success of an individual on his educational path and the demand for such a person in society in general and in the labor market in particular. When higher education teachers use the latest digital resources available on the market, these efforts become even more effective in increasing student engagement and interactivity. As the monitoring of online resources has shown, there are digital tools that create conditions for innovative activity of teachers and active educational activity of higher education students in the electronic educational environment (Yuriy et al., 2022).

Digital technologies are classified into several areas. Let's consider them:

- Learning Management Systems, such as Google Classroom, Moodle, WebCT, Canvas, and Blackboard, which at various levels contribute to the implementation of educational processes and support the implementation of online courses;
- Social networks, such as Facebook, Twitter, Instagram, Clubhouse, Ning, LinkedIn, and Academia.edu, play an important role in the exchange of experience between scientists and students and the establishment of professional contacts;
- Tools for interaction, publication, and sharing (podcasts, YouTube, video lectures, e-books, Google documents, Mind Maps, social bookmarks, Blogs, and Wikis, which facilitate knowledge exchange and collaboration;
- Virtual reality, real-time programs, online games, and virtual laboratories, which allow for experimentation and reproduce real conditions in controlled conditions;
- Mobile applications (apps), software for tablets, smartphones, and other mobile devices, which facilitate learning anywhere and at any time;
- Interpersonal communication tools, including e-mail, Viber, Telegram, ZOOM, WhatsApp, Telegram, Discord, Skype, forums, online projects, and webinars, which provide communication between participants in the educational process;
- Content aggregation tools, such as Google Reader, NetVibes, and RSS feeds, which help to quickly organize and collect text data;
- Feedback and assessment systems, such as electronic testing via Moodle and Google Forms, as well as electronic note-taking and reflection systems such as Evernote, Pages, and Trello.

The proposed classification is effective in forming students' professional competencies, indicates the importance of digital technologies in the training of students, contributes to the ability to independently solve educational tasks, and creates the possibility of active individual activity in the modern digital world.

The impact of digital technologies on the quality of higher education.

To form the digital competence of specialists and develop a system for forming the digital competence of students, to introduce changes, implement, and search for effective methods, forms, and means of forming the digital competence of a future specialist, we analyzed the impact of digital technologies on the quality of higher education.

The ability to expand and enrich traditional forms of education is one of the key aspects of the use of digital technologies.

Deeper involvement in the educational process of higher education applicants is facilitated by the interactivity provided by digital resources.

Digital tools and multimedia materials, such as virtual laboratories and simulations, bring diversity to teaching methods, which helps future specialists better develop practical skills in a controlled and safe environment and master complex concepts.

It can make learning more accessible and flexible – the use of open educational resources and online courses allows students to study the material at any convenient time and at the pace that is optimal for them. Each student can choose an individual approach to learning, taking into account their own educational goals and needs, which contributes to creating conditions for independent learning for each individual, which was taken into account in the experimental work when developing a system for forming students' digital competence.

Pedagogical opportunities in higher education are significantly expanded by digital technologies, in particular through the personalization of the educational process and increased accessibility.

With the help of digital technologies, the democratization of access to education opens up the opportunity for students from all over the world to receive high-quality knowledge without geographical restrictions.

Through the personalization of the educational process, the digitalization of education brings innovations. Artificial intelligence algorithms and intelligent educational systems allow you to customize educational content, taking into account the individual needs of each student and their characteristics.

This approach significantly increases students' motivation to learn and not only helps optimize the learning process since the material is presented in a clear, convenient way, adapted to the individual pace of the student for high-quality assimilation of information (Kovalskyi & Kyslenko, 2024).

There is a need to implement a digital revolution in the educational sector, given such rapid and significant rates of scientific and technological progress, since the modern information society requires fundamentally new approaches to obtaining a quality education, starting from the preschool age. With such an approach, it is worth looking for new ways, methods, and means of training highly qualified specialists who will be able to develop, disseminate, and implement digital education and who will have the basics of digital literacy. This task can be achieved within the walls of higher education through a qualitatively adjusted educational process (Karpliuk, 2019).

Digitalization in education, i.e., life-long learning, as well as its individualization based on advanced learning technologies, is aimed at ensuring the continuity of the learning process (lifelong learning). The content of digital technologies by individual students when studying certain disciplines includes the use of significant data in education about the process of professional growth, automatic adaptation of the educational process, the use of augmented reality, virtualization, cloud computing, and many other technologies (Karpliuk, 2019).

The impact of digital technologies on the quality of higher education depends directly on the level of mastery of digital technologies by the teacher to use them productively in educational activities. Today, there is a need to develop in teachers the ability to navigate the flow of digital information, process it, work with it, and integrate it into new pedagogical technology. The information format is based on the digital presentation of information. The digital format, unlike the electronic format, represents information more accurately, ensuring placement, processing, free circulation, and use in computer networks. The digital education system includes a management system, telecommunications, and information resources (Vasylyk & Kushnir, 2018). To form the digital competence of specialists and develop a system for forming the digital competence of students, to introduce changes, implement and search for effective methods, forms, and means of forming the digital competence of a future specialist, we used digital technologies in the educational process of higher education.

Recently, the process of using and creating open online resources has been actively implemented, ranging from tests and individual tasks to modules and full-scale courses to form the necessary competencies of a specialist. The growth in the availability of online courses demonstrates the dynamics of the development of online learning.

The practice of blended learning and online courses creates a field of unlimited educational opportunities that orient each person by their interests and capabilities to the quality of education, regardless of their skills and place of residence (Knysh et al., 2024).

The following changes require a teacher to be fluent in the digital educational environment. Therefore, a promising task for all higher education institutions is to improve digital literacy and teacher qualifications, focused on the use of the digital environment in the educational process, which requires teachers to have a different picture of the world, mentality, and perfect forms and methods of working with students (Marrero-Sánchez & Vergara-Romero, 2023).

Digitalization tasks are set for higher education institutions.

The higher education institution set the tasks of digitalization to form the digital competence of specialists and develop a system for forming the digital competence of students. The content of digital technologies and digital literacy of the individual comes down to understanding: if there is clarity in the structure and content of digital reality, then there will be clarity in interaction with digital technologies and in the control of knowledge and skills (Sulym et al., 2023).

Let's formulate the digitalization tasks that must be set for higher education institutions to form the digital competence of specialists and develop a system for forming the digital competence of students:

- Implementation of digital technologies in the educational process;
- Improving the qualifications and ensuring innovative training of higher education teaching staff on the use of digital technologies in educational activities;
- Providing the opportunity for free access to digital resources in cloud services and their collective use;
- Providing consulting and information services on the use of cloud and digital technologies with unlimited resources;
- Through the introduction of digital technologies – creating innovative conditions for development;
- Dissemination, systematization, and accumulation of information by a higher education institution on the use of cloud and digital technologies.
- Ensuring that teachers and students increase the level of motivation to use and professional improvement by introducing digital technologies into professional activities.

Having completed these tasks, the education system will be able to ensure a confident transition to the digital era of society, focused on virtual and augmented reality, building individual learning routes, increasing the productivity of the educational process, managing one's own learning outcomes, etc. (Karpliuk, 2019).

Principles and conditions for the formation of a digital environment of a higher education institution that affects the quality of higher education and the general strategic goals of the development of the educational system.

The formation of a digital environment for obtaining higher education should be based on innovative principles, which are necessary for the formation of the digital competence of specialists and the development of a system for the formation of the digital competence of students to introduce changes, implement and search for effective methods, forms, and means of forming digital competence of a future specialist:

- Compliance with the trends in the development of electronic learning (e-learning), world standards, and learning management;
- Integration into a networked multilayer world information space;
- Unification of navigation tools, which provides users with the opportunity to access all information resources conveniently and quickly;
- The presence of an information-network internal open structure that ensures the integration of administrative, scientific, and educational divisions of a higher education institution;
- Compliance with copyright and ensuring information security requirements.

The main goal of the digital environment of a higher education institution should be in an authorized mode, focused on different groups of users, in ensuring the possibility of interactive remote access to all innovative information educational resources.

When developing a system for forming students' digital competence, we considered the advantages of the digital environment of higher education to be: the possibility of using various multimedia components of educational materials, numerous open information resources, the presence of an e-portfolio that integrates learning outcomes, interactive communication in a subject context with other students and the teacher; flexibility of time parameters and learning trajectory. Such a digital environment of higher education provides the teacher with the opportunity to promptly update educational resources, adjust the educational process, carry out automatic monitoring of educational activities according to the needs of each student, control in detail, and organize the independent work of higher education applicants.

Today, in higher education, due to the impact of digital technologies on the quality of higher education, a new paradigm of equal access based on modern ICT to quality education is being formed.

An open process of the impact of digital technologies on the quality of higher education was carried out in the formation of digital competence of specialists and the development of a system for the formation of digital competence of students under such conditions in higher education:

- Development and formation in higher education institutions of a safe, educational environment and a pedagogically balanced environment;
- Introduction into educational practice of innovative digital technologies and methodological training systems, information and analytical systems for managing education and science and supporting scientific research;
- Ensuring access to digital technologies for all participants in the educational process of higher education, creating high-quality electronic educational resources;
- Ensuring timely updating of the composition and functioning of digital technologies;
- Conducting retraining, continuous training, and advanced training of personnel in the direction of creative and active use of digital technologies in professional activities;
- Ensuring the functioning and creation of units and institutions that support digital technologies and coordinate at all organizational levels the processes of informatization of the institution by the prospective and current tasks of the educational industry and society (Romanova et al., 2022).

Taking into account the general strategic goals of the development of the educational system when solving the problem of using digital technologies for high-quality higher education.

When solving the problem of using digital technologies for high-quality higher education, it is necessary to take into account (including innovative aspects) the general strategic goals of the system development and formation of digital competence of students to introduce changes, implement and search for effective methods, forms, and means of forming digital competence of a future specialist:

- Creation of virtual groups and formation of network communities for information exchange at the international and national levels;
- Creation of special services to help teachers based on publicly available resource centers;
- Improvement of skills in mastering digital technologies for high-quality higher education will allow teachers to use not only new programs in teaching but also to develop their own methods in the educational digital environment;
- Use of digital technologies in administrative work, and not only in educational activities, will ensure productive, more precise work with personnel and will allow more time and resources to be allocated to solving problems related to education;
- Systematic monitoring of the use of digital technologies for high-quality higher education.

Therefore, the use of digital technologies for high-quality higher education at the beginning of the 21st century is a strategic priority of socio-economic development and the educational policy of society (Tovkanets, 2018).

Virtual reality technologies and virtual modeling, electronic immersive learning technologies for high-quality higher education in the educational space.

To form digital competence in specialists and develop an original system for forming digital competence of students, we used virtual reality technologies and virtual modeling, electronic immersive learning technologies for high-quality higher education in the educational space. Virtual reality technologies and virtual modeling open up broad prospects for using the latest achievements of computer technologies in the educational space for high-quality higher education, provide teachers and students with convenient tools for teaching and learning, for the formation of practical professional skills, and contribute to the transfer of skills and knowledge to non-standard, new situations when learning organized in one context affects performance in another context (Kuchai et al., 2022). IVR technology significantly helps in such transfer of acquired experience to real situations. In the context of learned algorithms of actions and specific activities, it is virtual modeling that contributes to the actualization of knowledge (a virtual “tour” of the human brain using IVR aids in the productive assimilation of brain anatomy). (Shuliak et al., 2022).

In recent years, the ecosystem approach has been analyzed and discussed quite actively, which is relevant for all spheres of society, including the educational sector (Hrynevych et al., 2021). We used the ecosystem approach in forming digital competence in specialists and developing an author's system for forming digital competence in students in higher education as one of the solutions to the problem of forming practical skills that were acquired according to the traditional model.

The ecosystem approach is related to lifelong learning and means harmonious relationships between all components of the education system, teachers, and students. The ecosystem approach creates favorable conditions for thinking and developing new ways of learning, teaches to cooperate and live in a new way, and opens up space for the development and improvement of network learning models (network courses, virtual laboratories, and schools).

Effective modern electronic immersive learning platforms make it possible to display a different image for each eye, creating visual signals for the perception of image depth, tracking changes in head position, and, as a result, significantly increasing the size of the field of view compared to a conventional monitor. These factors are very important for creating innovative educational projects for developing meaningful and interesting content for higher education. That is why it was used in the formation of digital competence in specialists and the development of an author's system for the formation of digital competence in students in higher education.

Compared to traditional multimedia means, the determining factor of learning is the use of IVR – video, PowerPoint, a high level of interactive interaction, since instant feedback between real movements and the corresponding visual effect is a technical feature of the IVR educational environment, the ability to control the process of higher education, directing professional training in the desired direction (Knysh et al., 2023). As a mosaic of technologies, IVR can be considered to support the creation of spatial, highly interactive, synthetic, three-dimensional (3D) environments that simulate unreal situations or real ones. In the field of information technology, thanks to rapid progress and the spread of free and paid programs, today, you can get an exciting experience of immersion in virtual reality. Such opportunities associated with the introduction of technological approaches and methods that meet the needs of modern society open up new prospects for education. As a component of the educational ecosystem, digital learning platforms provide teaching online courses using audio-video communication, digital collaboration between teachers and students, general management of online teaching, creation of digital content and publication of courses; support the creation of video content, facilitate the exchange of information between the teacher and students, which forms digital ecosystems for work. And since many platforms are intuitively quite understandable, only basic knowledge of digital technology is required (Ulishchenko & Ulishchenko, 2022).

A digital university is a requirement of an innovative, modern digital educational space.

To develop effective teaching methods, it is important to understand the pedagogical aspects of using digital technologies in higher education that meet the requirements of an innovative modern educational space.

In recent years, the digitalization of the educational process of higher education has been recognized as a significant factor in the development of economic, political, cultural, and social relations in society. The concept of a “digital university” is revealed when it comes to the modernization of higher education and its main trends. During the transition of higher education institutions to distance and blended learning during the pandemic, even more, attention began to be paid to the issues of digitalization of higher education. The transition to a digital university from a traditional one involves a change in priorities, goals, organizational approaches, principles, corporate ideology, the structure of the institution, etc., and not just the quantitative accumulation of technical means. In the network, it is possible to combine digital individual universities for which there are no geographical restrictions and political boundaries, although the emergence of such higher education institutions requires a certain unification of requirements and rules for the participants of the association. The transition of higher education institutions to a digital innovative structure involves a set of measures in the following areas: economic, organizational, regulatory, ideological, and social (Reshetylov et al., 2022).

Modern universities have faced several challenges in creating an innovative modern digital educational space, namely:

- The need to form an optimal structure in a higher education institution and combine the components of this structure into an effective system (a digital university is formed precisely based on such a structure);
- Searching for a model of digitalization within the limits of the autonomy determined by each higher education institution;
- Determining the types of activities, tasks, and roles for teachers of such a university;
- Searching for methods and methods of distance learning corresponding to educational tasks;
- Combining effective network tools, technical means of learning, and elements of digital technologies, which are in each university, into a system based on which the digital university is formed;
- Replacing the virtual network, classroom (traditional) educational space with a virtual one;
- Establishing effective communication in the network environment of all participants in the educational process of higher education.

In response to significant changes in society, universities develop their own digital strategies through the use of new digital technologies while not having the ability, determination, and vision to effectively implement them.

Each digital university must maintain structural, organizational, content, and personnel originality in the conditions of functioning of open educational systems within the autonomy of the institution (legislated) and single educational legislation of the legal field.

The search for the optimal combination of the activities of a digital university and the regulatory unification of basic procedures and processes of organizational identity is the main challenge for implementers of ideas for the digitalization of higher education.

In the context of a digital university, distance learning is a coordinated time and space, purposefully organized process of educational interaction between teachers and students based on appropriate information technologies and technical means (Areshonkov, 2020).

Therefore, to form digital competence in specialists and develop an original system for forming digital competence in students, we tried to create a system of the educational process of a digital university in

higher education, which is a requirement of an innovative modern digital educational space and a necessity for developing effective teaching methods, understanding the pedagogical aspects of using digital technologies in higher education, which meet the requirements of an innovative modern educational space and are necessary for the further professional activities of each person.

The experiment

As a result of our work, a pedagogical experiment was conducted, which took place within the framework of the annual program.

In the current educational process, experimental work was carried out without violating the content of the curriculum and the structure of classes.

The experimental study was conducted during 2022–2024. It included interrelated stages of the experiment: analytical (2022), ascertaining (2023), formative (2024)

The program set the tasks of digitalization for the higher education institution to form the digital competence of specialists and develop a system for forming the digital competence of students. The formation of the digital environment for obtaining higher education should be based on innovative principles that are necessary for the formation of the digital competence of specialists and the development of a system for forming the digital competence of students to introduce changes, implement and search for effective methods, forms, and means of forming the digital competence of a future specialist. When solving the problem of using digital technologies for high-quality higher education, we took into account (including innovative aspects) the general strategic goals of developing the system for forming the digital competence of students. To form the digital competence of specialists and develop an original system for forming the digital competence of students, we used virtual reality technologies and virtual modeling, electronic immersive learning technologies for high-quality higher education in the educational space.

To form digital competence in specialists and develop an author's system for forming digital competence in students, we at the higher school tried to create a system of the educational process of a digital university, which is a requirement of the innovative modern digital educational space and a necessity for developing effective teaching methods, understanding the pedagogical aspects of using digital technologies in higher education, which meet the requirements of the innovative modern educational space and are important in the further professional activities of specialists.

To determine the level of formation of a specialist's digital competence, we conducted surveys of students divided into CG and EG regarding the formed skills of working with digital tools and existing knowledge that emphasize digital competence. The CG and EG groups consisted of graduating students of socio-economic specialties.

The summarized results of the initial levels of formation of digital competence of specialists EG and CG at the ascertaining stage of the study indicate the need to develop a system for the formation of a specialist's digital competence, introduce changes, implement and search for effective methods, forms, and means of forming the digital competence of a future specialist.

Therefore, the implementation of the system for the formation of a specialist's digital competence involved conducting a formative stage of the experiment.

Based on the research described above, we developed a system for the digital competence of a specialist: We identified the prerequisites for the formation of a specialist's digital competence:

- Taking into account virtual reality, information reality, and the features of the information society;
- Substantiation of the digital competence of a specialist;

- Interpretation of the interdependence of the digital competence of a specialist and his competence;
- The soundness of the teacher's digital competence based on the systematic consideration of laws, categories, and methods;
- Improving the level of formation of digital competence.

The main principles of the formation of the digital competence of a specialist were the priority of the human factor, integrity and comfort of the educational environment, adaptability, systematicity, reproducibility, cooperation, conformity to nature, variability, and unity of forms of self-education and training.

For the formation of the digital competence of a specialist, the following important approaches were identified: a synergistic approach, an integrative approach, a systemic approach, an axiological approach, an andragogical approach, and a competency-based approach.

Indicators were formed to determine the effective content and methodological support of the system for the formation of the digital competence of a specialist:

- A set of practical tools and methods of the educational process;
- Open educational digital resources;
- Curricula and courses for the professional training of specialists;
- Materials for the student's independent study.

We took into account the fact that the answers to the questions reflect the most accurate picture of the digital competence of a specialist, and it is the answers to the questions that are required from users and are based on the results of performing innovative tasks, we formed the levels based on the results, not through self-assessment.

As the results of the ascertaining stage of the experiment showed, the majority of respondents were at the following levels (Fig. 1):

- High level (professional) – 20%;
- Medium level (user) – 41%;
- Low level (beginner) – 39%.

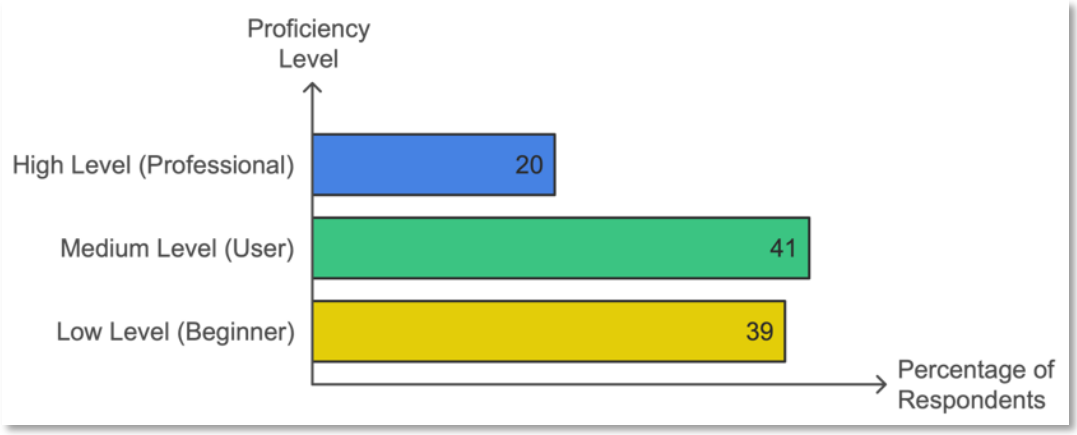

Figure 1. Proficiency Levels of Respondents.

After the formative stage of the experiment, diagnostics of the level of formation of the digital competence of the future specialist were carried out twice.

Positive dynamics were observed at each level (Fig. 2):

- At the beginner level – the percentage of respondents decreased to 13% from 39%;
- At the user level – the percentage of respondents decreased to 11% from 41%;
- At the professional level – the percentage of respondents increased to 76% from 20%.

The participants of the experiment stated that the most relevant form of digital competence formation is:

- Offline training accompanied by a trainer – 23.3%;
- A combination of online and offline methods – 27.7%;
- Online training – 44.8%.

To conduct a statistical analysis at the beginning of the experiment and at the time of its completion, we compared the state of the group. In this case, Fisher's angular transformation was used.

In our case, the state of the subjects at the beginning and the end of the experiment was considered. A comparison was made according to the frequency of the studied indicators (generalized indicators; the level of formation of each of the components). The conversion into the values of the central angle of the percentages, given in radians, is the Fisher angular transformation φ. A larger percentage corresponds to a larger angle $\varphi 1$ and a smaller angle $\varphi 2$ to a smaller one. It should be noted that the relationship between these values is nonlinear: $\varphi = 2arcc\overline{i}n\sqrt{P}$, (1), where P is the percentage expressed in fractions of a unit. The values of the criterion increase with an increase in the number of samples or an increase in the angles of divergence. The existing differences between the samples are non-random, the more likely, the larger the value of φ.

At the final stage of the formative experiment, as a result of the statistical verification of the results, it was found that under the proposed system for the formation of a specialist's digital competence, the levels of each of the components and their generalized indicators increased significantly, which was confirmed by the Fisher angular transformation.

Table 1.
Calculation of the Fisher criterion for the final stage

Indicator	Stage		Accepting the hypothesis
	Beginning	Terminal	
Environmental component			
Proportion value when "There is an effect", %	12,37	73,10	We accept hypothesis H1
Angular transformation	0,7188	2,0510	
Empirical value of the criterion	82,11		
Criterion significance level	0,01		
Content component			
Proportion value when "There is an effect", %	22,18	75,48	We accept hypothesis H1
Angular transformation	0,9807	2,1055	
Empirical value of the criterion	69,33		
Criterion significance level	0,01		
Communicative component			
Proportion value when "There is an effect", %	0,0853	0,7810	We accept hypothesis H1
Angular transformation	0,5927	2,1676	

Empirical value of the criterion	2,1676		
Criterion significance level	0,01		
Generalized indicator			
Proportion value when "There is an effect", %	14,36	75,56	We accept hypothesis H1
Angular transformation	0,7773	2,1074	
Empirical value of the criterion	81,98		
Criterion significance level	0,01		

Thus, the effectiveness of the implementation of the system for forming a specialist's digital competence was analyzed, a quantitative and qualitative analysis of the results obtained was conducted, and the corresponding conclusions were drawn: a cross-sectional analysis and interpretation of the research results showed that under the proposed system for forming a specialist's digital competence, the levels of each of the components and their generalized indicators increased significantly, which was confirmed by the Fisher angular transformation.

The study had the following statistical hypotheses:

- H0: the level of formation at the end of the experiment of the corresponding indicator is not higher than at the beginning of the experiment;
- H1: the level of formation at the end of the experiment of the corresponding indicator is higher than at the beginning of our experiment.

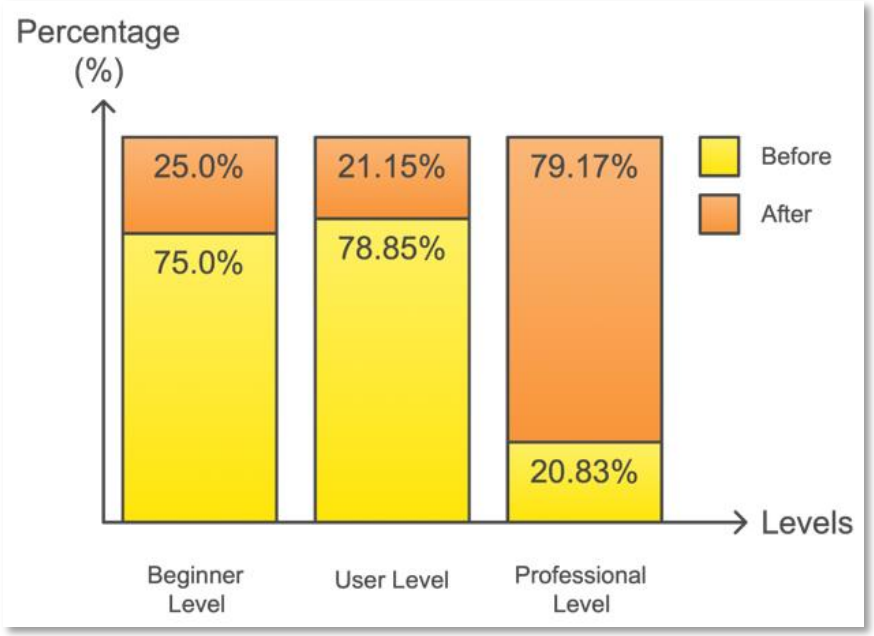

Figure 2. Respondent Percentage Changes by Level.

To conduct a statistical analysis at the beginning of the experiment and at the time of its completion, we compared the state of the group. Fisher's angular transformation was used. The effectiveness of the developed system for forming a specialist's digital competence is evidenced by the obtained indicators.

The effectiveness and efficiency of training were checked using the consumer loyalty index – NPS and key performance indicators – business indicators KPI, which are universal.

To assess the quality of the training organization, we used the NPS (Net Promoter Score) consumer loyalty index. Respondents were classified by their degree of readiness to recommend the digital competence formation system (training, methodology) to other people using questions.

When receiving the NPS index, we made the following conclusions:

- An index of more than 50% indicates high results, where the respondent is noted as a leader in the labor market with a high level of digital competence formation using the system for the formation of a specialist's digital competence;
- From 30% to 50%, the index indicates a good result of the formation of the level of digital competence using the system for the formation of a specialist's digital competence. However, we took into account that a series of errors or a negative incident can affect the reputation of the organizer of the system for the formation of a specialist's digital competence;
- Up to 30%, the index indicates the presence of minor problems in the formation of the level of digital competence using the system for the formation of a specialist's digital competence, which requires attention to all structural divisions that conduct direct training;
- Less than 0% – a negative index, which indicates that the number of respondents dissatisfied with the system for forming the digital competence of a specialist significantly exceeds the number of satisfied respondents and is a systemic problem.

The calculation of the NPS indicator of the experimental course is given in Table 2.

Table 2.
Calculation of the NPS indicator

Level	Indicator	Value
Intermediate level	Vd, detractors - percentage	11
	Vp, promoters – percentage	59
	NPS= Vp-Vd	48

The NPS index we obtained = 48, which indicates a high-quality organization of training in general and indicates a high-quality experiment, a correctly chosen tactic, and a strategy for building a training system, which is based on the effective formation of digital competence of respondents using the developed system. Since the respondents who are studying will be competitors in the services market, we assessed the results of the experimental work using the Key Performance Indicators (KPI) indicator.

Key performance indicators are KPIs used to assess the achievement of goals and their clear reflection or optimality of the process and are measured in numbers, as well as achieving efficiency and effectiveness of the process. An important management tool is key performance indicators, which allow you to evaluate and control the work of departments, working groups, individual specialists, and companies. KPI analysis contributed to the assessment of the implementation of the selected strategy for forming the digital competence of a specialist. In our study, the indicators were:

- KPI – the ratio of respondents who successfully completed their training and the formation of their digital competence corresponds to a high level;
- KPI-2/1, KPI-3/1, KPI-3/2 – the ratio of respondents who joined the number of participants of the previous level – to the next level. During the basic level of the training course, an experiment was conducted in which we analyzed the dynamics of the results obtained in the context of each of the levels.
- More than 75% of students successfully completed the basic level of training, which for a mass course is a very high indicator of the formation of their digital competence (the indicator fluctuates within 10-25%);
- 82% of respondents passed the average level of training;

– 72% of respondents passed the advanced level of the course (data according to the KPI indicator).

Other indicators (KPI-2/1, KPI-3/2, KPI-3/1) indicate that after completing training on the developed system for the formation of digital competence of specialists of the full-fledged basic level course, we managed to keep the attention of respondents who joined the advanced level of the course and the intermediate level of the course. More than 20% of respondents successfully completed three levels of training on the developed system for the formation of digital competence of specialists.

We note that there were no requirements for mandatory training at all levels because the material of the basic course already allowed respondents to effectively use the proposed digital tools in their professional activities, which was provided to them by the developed system for the formation of digital competence of specialists.

The analysis of data obtained during the sections of the formative stage of work recorded positive dynamics in the EG.

Therefore, the results of the study correlate with the goals of the study regarding the formation of students' skills in working with digital tools and obtaining existing knowledge that emphasizes the digital competence of future specialists, which can be achieved thanks to the developed system for forming the digital competence of a specialist, by introducing changes, implementing and searching for effective methods, forms, and means of forming the digital competence of a future specialist.

Conclusions

The content of the concept of "digital technologies" is presented, and their classification is proposed, which is effective in the formation of students' professional competencies and indicates the importance of digital technologies in the training of students, promotes the ability to independently solve educational tasks, creates the possibility of active individual activity in the modern digital world.

The impact of digital technologies on the quality of higher education is shown. The tasks of digitalization set before the higher education institution are analyzed; the principles and conditions for the formation of the digital environment of higher school are revealed, which affect the quality of higher education and the general strategic goals of the development of the educational system.

The general strategic goals of the development of the educational system are taken into account when solving the problem of using digital technologies for high-quality higher education.

The importance of virtual reality technology is shown, and virtual modeling electronic immersive learning technologies for high-quality higher education in the educational space are revealed. The importance of the Digital University is demonstrated as the requirements of an innovative modern digital educational space.

A pedagogical experiment was conducted within the framework of the annual program.

The summarized results of the initial levels of formation of digital competence of EG and CG specialists at the ascertaining stage of the study indicate the need to develop a system for the formation of digital competence of a specialist, introduce changes, implement and search for effective methods, forms, and means of forming digital competence of a future specialist.

Therefore, the implementation of the proposed system for the formation of digital competence of a specialist involved the conduct of the formative stage of the experiment.

The prerequisites for the formation of digital competence of a specialist were identified.

The main principles for the formation of the digital competence of a specialist were the priority of the human factor, integrity and comfort of the educational environment, adaptability, systematicity, reproducibility, cooperation, nature-relatedness, variability, unity of forms of self-education, and training.

For the formation of the digital competence of a specialist, the following important approaches were identified: synergistic approach, integrative approach, systemic approach, axiological approach, andragogical approach, and competency approach.

Indicators have been formed to determine the effective content and methodological support of the system for forming a specialist's digital competence.

The effectiveness of the implementation of the system for forming a specialist's digital competence was analyzed, a quantitative and qualitative analysis of the results obtained was conducted, and the corresponding conclusions were drawn: a cross-sectional analysis and interpretation of the research results showed that under the proposed system for forming a specialist's digital competence, the levels of each of the components and their generalized indicators increased significantly, which was confirmed by the Fisher angular transformation.

Analysis of data obtained during the sections of the formative stage of work recorded the dynamics.

The results of the study correlate with the goals of the study regarding the formation of students' skills in working with digital tools and obtaining existing knowledge that emphasizes the digital competence of future specialists, which can be achieved thanks to the developed system for forming the digital competence of a specialist, by introducing changes, implementing and searching for effective methods, forms, and means of forming the digital competence of a future specialist.

Prospects for further scientific exploration are the study of the role of digital learning in European countries in the system of professional training of future specialists and the possibility of effective implementation of best practices in their educational activities.

Bibliographic references

Areshonkov, V. (2020). Digitalization of higher education: challenges and answers. *Herald of the National Academy of Educational Sciences of Ukraine, 2*(2), 1-6. https://doi.org/10.37472/2707-305X-2020-2-2-13-2

Bernazyuk, O. O. (2017). The problem of scientific definition of the concept of digital technologies in management. Scientific Bulletin of Uzhgorod National University. *Law Series, 47*(2), 83-86. https://dspace.uzhnu.edu.ua/jspui/handle/lib/33965

Hedzyk, A. (2024). Current trends in the use of network digital technologies in higher education: distance learning and massive open online courses (MOOCs). *Pedagogical Academy: Scientific Notes*, *(6).* https://doi.org/10.57125/pedacademy.2024.05.29.03

Hrynevych, L. M., Morze, N. V., Vember, V. P., & Boiko, M. A. (2021). The role of digital technologies in the development of the STEM education ecosystem. *Information Technologies and Learning Tools, 83*(3), 1-25. https://doi.org/10.33407/itlt.v83i3.4461

Karpliuk, S. O. (2017). Information and pedagogical management of higher education: current state and development prospects. *Scientific Bulletin of Uzhgorod University. Series: Pedagogy. Social Work*, *(2)*, 122-125. http://nbuv.gov.ua/UJRN/Nvuuped_2017_2_31

Karpliuk, S. O. (2019). Features of digitalization of the educational process in higher education. In *Information and digital educational space of Ukraine: transformation processes and development prospects* (pp. 188–197). Materials of the methodological seminar of the National Academy of Sciences of Ukraine, 188-197. http://eprints.zu.edu.ua/29742/1/Карплюк%20С._стаття%20в%20НАПН_1.03-перетворено_copy.pdf

Knysh, I., Budanova, O., Vakulenko, S., Syrotina, O., & Popychenko, S. (2023). Innovative educational technologies as a way of higher education enhancement. *Amazonia Investiga, 12*(68), 21–32. https://doi.org/10.34069/AI/2023.68.08.2

Knysh, I., Drobin, A., Filimonova, T., Koycheva, T., Kushnir, A., & Kuchai, O. (2024). The use of information technologies in the educational space of Ukraine (on the example of STEAM technologies). *Revista Conrado, 20*(100), 437–448. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3979

Koval-Mazyuta, M., Bakhmat, N., Sonechko, O., Fedotov, V., & Kustovska, O. (2023). Information and communication and digital technology in education: Some aspects of SMART technology application. *Amazonia Investiga, 12*(62), 336–344. https://doi.org/10.34069/AI/2023.62.02.34

Kovalskyi, V. O., & Kyslenko, D. P. (2024). Pedagogical aspects of the use of digital technologies in higher education. *Academic Visions, (30)*. https://doi.org/10.5281/zenodo.13294205

Kuchai, O., Hrechanyk, N., Pluhina, A., Chychuk, A., Biriuk, L., & Shevchuk I. (2022). World Experience in the Use of Multimedia Technologies and the Formation of Information Culture of the Future Primary School Teacher. *International Journal of Computer Science and Network Security, 22*(3), 760-768. https://doi.org/10.22937/IJCSNS.2022.22.3.100

Marrero-Sánchez, O., & Vergara-Romero, A. (2023). Digital competence of the university student. A systematic and bibliographic update. *Amazonia Investiga, 12*(67), 9–18. https://doi.org/10.34069/AI/2023.67.07.1

Mytnyk, A., Uninets, I., Ivashkevych, E., Rashkovska, I., Ivashkevych, E., & Kuchai, O. (2024). Formation of professional competence in future psychologists using innovative technologies. *Revista Conrado, 20*(100), 293–304. https://conrado.ucf.edu.cu/index.php/conrado/article/view/3963

Reshetylov, K., Rajab Aljad, R., Panchenko, H., Bukliv, R., & Vynograd, O. (2022). Digital transformation of education and science: responses to modern challenges. *Amazonia Investiga, 11*(58), 202–211. https://doi.org/10.34069/AI/2022.58.10.22

Romanova, I., Kudin, S., Rybak, O., Zavalevskyi, Y., & Pushkarova, T. (2022). Influence of digital technologies of distance education on the mental health of a child in the conditions of wartime realities. *Amazonia Investiga, 11*(56), 224–231. https://doi.org/10.34069/AI/2022.56.08.22

Shuliak, A., Hedzyk, A., Tverezovska, N., Fenchak, L., Lalak, N., Ratsul, A., & Kuchai, O. (2022). Organization of Educational Space Using Cloud Computing in the Professional Training of Specialists. *International Journal of Computer Science and Network Security, 22*(9), 447-454. https://doi.org/10.22937/IJCSNS.2022.22.9.58

Sulym, V., Melnykov, A., Popov, M., Vechirko, O., & Malets, D. (2023). Improving education through implementation of information technologies into the educational process. *Amazonia Investiga, 12*(68), 281–293. https://doi.org/10.34069/AI/2023.68.08.26

Tovkanets, O. S. (2018). Strategic directions of development of information and communication technologies in higher European school at the beginning of the 21st century. *Information Technologies and Learning Tools, 66*(4), 14–23. https://dspace.uzhnu.edu.ua/jspui/handle/lib/39232

Ulishchenko, A., & Ulishchenko, V. (2022). Peculiarities of immersion educational technologies in higher school. *Current Issues of the Humanities: Interuniversity Collection of Scientific Works of Young Scientists of the Ivan Franko Drohobych State Pedagogical University*, *(51)*, 702–709. https://doi.org/10.24919/2308-4863/51-108

Vasylyk, A. V., & Kushnir, A. I. (2018). Competences of HR-specialist in the digital technologies era. *Scientific Bulletin of Kherson State University*, *(9)*, 119-127. https://ej.journal.kspu.edu/index.php/ej/article/view/48

Yuriy, R., Huzchenko, S., Lobach, N., Karbovanets, O., Bokova, S., & Isychko, L. (2022). Modern digital learning and simulation technologies in higher medical education: definitions, innovative potential. *Amazonia Investiga, 11(*60), 53–61. https://doi.org/10.34069/AI/2022.60.12.6

Zhurba, M. A. (2013). Digitalization of culture and media risks: metaphysical aspect. *Bulletin of Dnipropetrovsk University. Series: Philosophy. Sociology. Political Science, 21*(23(2)), 114-120. http://nbuv.gov.ua/UJRN/vdufsp_2013_21_23(2)__23

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.19
Cómo citar:
Petrukha, N., Petrukha, S., Karashchenko, V., Shuman, V., & Ptashchenko, O. (2024). Financing the education and research sector in times of war. *Revista Eduweb*, *18*(4), 286-296. https://doi.org/10.46502/issn.1856-7576/2024.18.04.19

Financing the education and research sector in times of war

Financiación del sector de la educación y la investigación en tiempos de guerra

Nina Petrukha
https://orcid.org/0000-0002-3805-2215
nninna1983@gmail.com
Ph.D. in Economics, Associate Professor, Docent of the Department of Management in Construction, Kyiv National University of Construction and Architecture, Kyiv, Ukraine.
Sergii Petrukha
https://orcid.org/0000-0002-8859-0724
psv03051984@gmail.com
Ph.D. in Economics, Associate Professor, Docent of the Department of Management in Construction, Kyiv National University of Construction and Architecture, Kyiv, Ukraine.
Viacheslav Karashchenko
https://orcid.org/0009-0002-7792-1900
karashchenko27@gmail.com
Postgraduate Student, Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine.
Volodymyr Shuman
https://orcid.org/0009-0004-9811-5742
madidol04@gmail.com
Postgraduate Student, SESE “The Academy of Financial Management”, Kyiv, Ukraine.
Olena Ptashchenko
https://orcid.org/0000-0002-2413-7648
helenavaleriya@gmail.com
D.Sc. in Economics, Professor, Department of Entrepreneurship and Trade, West Ukrainian National University, Ternopil, Ukraine.

Recibido: 01/11/24
Aceptado: 27/12/24

Abstract

In the context of a full-scale war, new needs and issues arise in Ukraine's educational and scientific sectors. The article aims to study the characteristics of financing Ukraine's educational and scientific sphere. The study used general scientific methods of statistical analysis and systematisation of the results of studying the state, structure and features of financing Ukraine's educational and scientific sphere in the conditions of war. The article highlights the latest trends in changing the directions and approaches to financing Ukraine's educational and scientific sphere in the context of war. The study demonstrates the ability of the government and local authorities to provide financial support for this sector in the context of a full-scale war. In general, expenditures on education and science decreased only in 2022, both at the expense of the state and local budgets. Instead, in 2023-2025, the amount of planned state budget expenditures on education and science in Ukraine is growing. The work's practical value lies in highlighting the status and trends of financing the education sector at the expense of the state and local budgets and identifying the

peculiarities of the structure of expenditures on education of the state and local budgets by level of education.

Keywords: education, higher education institutions, state budget, research sector, war.

Resumen

En el contexto de una guerra a gran escala, surgen nuevas necesidades y problemas en los sectores educativo y científico de Ucrania. El artículo pretende estudiar las características de la financiación de la esfera educativa y científica de Ucrania. En el estudio se han utilizado métodos científicos generales de análisis estadístico y sistematización de los resultados del estudio del estado, la estructura y las características de la financiación de la esfera educativa y científica de Ucrania en condiciones de guerra. El artículo pone de relieve las últimas tendencias en el cambio de las direcciones y enfoques de la financiación de la esfera educativa y científica de Ucrania en el contexto de la guerra. El estudio demuestra la capacidad del gobierno y de las autoridades locales para prestar apoyo financiero a este sector en el contexto de una guerra a gran escala. En general, los gastos en educación y ciencia sólo disminuyeron en 2022, tanto a expensas del presupuesto estatal como de los locales. En cambio, en 2023-2025, el importe de los gastos previstos del presupuesto estatal en educación y ciencia en Ucrania está creciendo. El valor práctico del trabajo radica en poner de relieve la situación y las tendencias de la financiación del sector de la educación a cargo de los presupuestos estatales y locales y en identificar las peculiaridades de la estructura de los gastos en educación de los presupuestos estatales y locales por nivel educativo.

Palabras clave: educación, instituciones de enseñanza superior, presupuesto estatal, sector de la investigación, guerra.

Introduction

In the context of a full-scale war, new needs and issues arise in Ukraine's education and research sector that require additional funding. The risks of shelling social infrastructure necessitate the transfer of educational institutions to distance learning, which means spending on digitalising educational processes and constructing shelters in schools to ensure the safety of staff, pupils and students. The internal displacement of the population also required addressing the issues of adaptation of pupils and students to the new learning environment. At the same time, the need to finance the security and defence sector has reduced the potential for allocating funds to the education and research sector.

The factors that had a favourable impact on the financing of the education and research sector include fiscal decentralisation, which contributed to the transfer of authority in the management of educational institutions, the formation of educational budgets to local governments, and the provision of free and accessible educational services. Accordingly, during the war, local authorities were responsible for addressing issues related to the financing of education: infrastructure development, innovation, and logistics. At the same time, the central government allocates subsidies to the education sector (Law of Ukraine No. 280/97-VR, 2024).

As for the research, the sector has traditionally been characterised by low public and private funding levels for several reasons. The knowledge intensity of Ukraine's GDP has also remained low compared to EU countries over the past ten years (less than 1% of GDP, compared to the EU average of 2.2% in 2023) (Eurostat, 2024a). The reasons for this situation include the underdevelopment of state mechanisms for cooperation between the private and scientific sectors, which would allow scientists to sell their research and development to businesses directly. Limited public spending on the research sector is also a key reason for the low financial support. In addition, research centres at universities are relatively underdeveloped in Ukraine, and no local agencies support the scientific sector under local executive authorities.

Given the above, the issue of highlighting the specifics of financing Ukraine's educational and scientific

sphere in the context of war is becoming relevant. The article aims to study the specific features of financing Ukraine's educational and scientific sphere. The main objects of the study are 1) the state of financing of the educational sector at the expense of the State and local budgets; 2) the structure of expenditures on education of the State and local budgets by levels of education; 3) the state of financing of the scientific sphere in Ukraine by types of research work, sectors, and sources of financing.

Literature Review

Scholars discuss the issue of financing the education and research sector in the context of political, economic, and historical factors influencing the expenditures of these sectors of the economy. Political approaches to financing primary, secondary, and higher education, including ideological, historical, and institutional factors influencing such a system, are covered by Ansell & Lindvall (2015) and Rizvi & Lingard (2015). Pellegrini & Vivanet (2021) examine the implications of evidence-based policies for the EU's education and research sector. The role of public policy in ensuring access to educational services and reducing social inequality is studied by McGuinness (2016), Cantwell (2021), and Lee (2021).

Estermann & Pruvot (2015) and Sá & Sabzalieva (2018) have studied the degree of influence of higher education institutions' financial autonomy on the efficiency of their use of financial resources and the achievement of their development's strategic goals. Scott (2015) also examine the relationship between universities' financial independence and social responsibility.

Another area of research in education financing is the funding sources and the quality and accessibility of educational services (Chattopadhyay, 2007; Lung et al., 2012; Mintz, 2021). The findings on the structure of public and private funding of higher education and its impact on the quality of educational services are interesting. In particular, Teixeira & Dill (2000) study how privatisation and the ratio of public-private sources of education funding have affected the quality of education in different countries. Ziderman (2017) assesses the role of student loans in increasing access to higher education. Psacharopoulos & Patrinos (2018) estimate the economic return on investment in education at the individual and national levels. Mintz (2021) highlights the problem of financing education through public subsidies in the context of tax efficiency in OECD countries and notes their regressivity.

Vorontsova et al. (2020) studied the interrelationships between state regulation of education and economic growth and achieving sustainable development goals in CEE countries in 2006-2016. As a result, the most effective instrument of regulation was found to be public funding of education. Agasisti & Bertoletti (2022) found no significant impact on the economic growth of different funding sources (public, private) in European regions from 2000-2017. Busu et al. (2021) conduct an empirical analysis of the cost per student, the share of GDP allocated to higher education in the EU.

Another area of research concerns the accessibility of education and overcoming social inequality in access to educational services. Goldrick-Rab & Steinbaum (2014) and Marginson (2016) analyse the impact of financial mechanisms on social mobility and reduce inequality in access to quality education.

The specific issues of financing education and science are considered by Marginson (2016), Maringe (2023), & OECD (2022). Innovative funding models and the search for new mechanisms for financing the education and research sector, mainly to ensure efficiency and equity in resource allocation, are discussed by Jongbloed & Vossensteyn (2016) and Hedges & Rhoads (2016). Using regression analysis, Krstić et al. (2020) found a significant correlation between higher education and sustainable development.

Regarding expenditures on the research sector, most studies discuss the impact of R&D funding on innovation and economic growth in the EU. In particular, the article examines the convergence of EU countries in terms of R&D expenditures in 2004-2015, which revealed marked differences between countries in the level of expenditures due to the differentiation of the private sector, higher education, and

different public sector R&D expenditures (Blanco et al., 2020). Simionescu et al. (2021) empirically prove the impact of R&D expenditures on the GDP dynamics of EU countries in 2004-2018. Androniceanu et al. (2020) found higher GDP growth in EU countries with higher levels of R&D investment. Celli et al. (2024) discovered no significant impact of R&D expenditures on regional economic growth in the EU's lagging regions.

At the same time, few studies have examined the state and problems of financing the education and research sector in the context of a prolonged war, which causes the diversion of financial resources from human capital development to the security and defence sector.

Methodology

The study is based on general methods of scientific knowledge, statistical analysis of the state of financing the education sector at the expense of the state and local budgets, the structure of expenditures on education of the state and local budgets by levels of education, and the state of financing of the scientific sphere in Ukraine by types of research, sectors, and sources of funding. The data from the State Statistics Service of Ukraine and the Open Budget platform were used for the detailed analysis.

The article presents a descriptive-analytical study of the impact of the war on the state and structure of financing for the education and research sector in Ukraine. The main objective is to summarise the trends in financing the education and research sphere before and after the beginning of the war. The data collection process involved summarising existing information and secondary data on financial provision for education and research, published on the official websites of the Ministry of Education and Science of Ukraine, as well as using databases from the State Statistics Service of Ukraine and the World Bank's "Open Budget platform." Secondary data from expert interviews published on the website of the Ministry of Education and Science were processed to understand approaches to financing in wartime conditions. Statistical analysis of education sector financing was conducted for the years 2018–2024, using data from the "Open Budget platform" and included the following variables: 1) Expenditure from the state budget for financing education by functions in Ukraine during 2018–2024; 2) Expenditure from local budgets of all regions of Ukraine and Kyiv for financing education by functions in Ukraine during 2018–2024. Statistical analysis of the research sector in Ukraine was conducted based on the following variables: 1) The volume of expenditures on research and development (R&D) in Ukraine by type of activity during 2010–2023, and their share in Ukraine's GDP during 2010–2023; 2) The volume of R&D expenditures in Ukraine by sectors during 2021–2023; 3) The structure of R&D expenditures in the business sector by sources of funding during 2022–2023; 4) The volume and structure of expenditures on research and development in Ukraine by fields of science during 2021–2023. Data for the analysis of the research sector's financing were obtained from the State Statistics Service of Ukraine. All calculations (tables and figures) were prepared using Excel. The criteria for verifying the data included assessing the reliability of data on education and research financing volumes as presented on the Open Budget platform, the Ministry of Education and Science, and the State Statistics Service. The main methodological limitations of the study are associated with the lack of complete data on education financing by function from local budget expenditures due to the decentralisation process in Ukraine, which began in 2015. The Open Budget platform only contains data on education expenditures from 2018 onwards.

Results and discussion

In total, UAH 143.4 billion was allocated to finance Ukraine's education and research sector in 2023, UAH 176.2 billion in 2024, and UAH 194.3 billion in expenditures are planned in the State Budget for 2025. In 2024-2025, the budget for education and science increased by 35%. In particular, the growth was driven by increased allocations for school shelters to ensure the continuity of education and the purchase of buses. Funding for the New Ukrainian School reform increased by almost 50% in 2024-2025, bringing the planned budget to UAH 2.15 billion in 2025 (UAH 1.5 billion in 2024). It should be noted that the reform involves purchasing new equipment, developing teachers' professional skills, and updating teaching aids. In 2025, it is also planned to spend UAH 540 million on training and practical centres of vocational education

institutions, laboratories, and workshops of vocational colleges. A positive trend is the provision of funding for vocational pre-university and higher education, which is planned to be funded at UAH 55.6 billion. Only UAH 3.3 billion will be provided for science in 2025 (Ministry of Education and Science of Ukraine, 2024).

During 2018-2021, education spending in Ukraine increased from UAH 44.31 billion to UAH 63.84 billion, but in 2022 it decreased to UAH 58.5 billion, with an increase to UAH 60.45 billion in 2023. In 2018-2023, spending increased by UAH 16.15 billion, and its share in state budget expenditures decreased by 2.99% (4.5% in 2018, only 1.51% in 2023) (Table 1).

Table 1.
Dynamics of state budget expenditures on education in Ukraine in 2018-2024, billion UAH

Features	2018	2019	2020	2021	2022	2023	2024	Deviation (2018-2023), +/-
State budget, total expenditures, UAH billion	985,37	1072,89	1288,02	1490,26	2705,42	4014,42	2977,71	3029,05
Expenditures on education, UAH billion	44,31	54,49	61,7	63,84	58,5	60,45	44,4	16,15
Share of expenditures on education, %	4,5	5,08	4,79	4,28	2,16	1,51	1,49	-2,99
Preschool education	-	-	4,26	-	-	-	-	-
General secondary education	0,4	0,39	0,37	0,49	0,48	0,48	0,46	0,08
Professional (vocational) education	0,28	0,36	0,39	0,46	0,48	0,44	0,32	0,15
Vocational pre-university and higher education	36,69	43,04	48,36	53,8	49,88	50,2	35,98	13,5
Postgraduate education	1,0	1,11	1,1	0,98	0,31	0,31	0,23	-0,69
Extracurricular education and out-of-school activities for children	0,33	0,43	0,34	0,64	0,38	0,42	0,46	0,1
Programmes for the material support of educational institutions	0,8	1,06	0,52	0,68	0,09	1,41	1,2	0,61
Basic and applied research and development in education	1,23	1,29	1,32	1,75	1,22	1,64	1,23	0,41
Other institutions and activities in the field of education	3,57	6,82	5,04	5,04	5,66	5,55	4,53	1,98

Source: calculated by the author of Open Budget (2024)

The most significant amounts of state budget expenditures were allocated to vocational pre-university and higher education (UAH 36.69 billion in 2018, UAH 50.2 billion in 2023), while other educational levels lag far behind in funding. Thus, in 2023, UAH 0.48 billion was allocated for general secondary education, only UAH 0.44 billion for vocational education, UAH 0.31 billion for postgraduate education, and UAH 0.42 billion

for out-of-school education and related activities. In 2018, UAH 0.8 billion was allocated for material support programmes for educational institutions, and UAH 1.41 billion in 2023. Budget allocations for basic applied research and development in education increased slightly: UAH 1.23 billion in 2018 and UAH 1.64 billion in 2023.

For comparison, local budget expenditures on preschool education in 2018-2023 increased by UAH 13.49 billion, on secondary education by UAH 48.48 billion, on vocational education by UAH 6.06 billion, and professional pre-university and higher education by UAH 3.69 billion (Table 2). A slight decrease in spending on preschool, secondary, vocational, and postgraduate education was recorded in 2022, while in 2023, there was an increase in spending on education at the local level.

Table 2.
Dynamics of local budget expenditures in all regions and Kyiv to finance the education sector in Ukraine in 2018-2024, billion UAH

Features	2018	2019	2020	2021	2022	2023	2024	Deviation, +/-
Preschool education	31,79	36,04	37,56	48,54	40,67	45,28	34,42	13,49
General secondary education	101,29	114,89	122,08	149,56	144,86	149,77	113,95	48,48
Professional (vocational) education	9,72	10,46	11,12	13,72	15,02	15,78	11,30	6,06
Vocational pre-university and higher education	7,55	8,32	8,91	11,05	10,85	11,25	8,33	3,69
Postgraduate education	0,68	0,75	0,73	0,90	0,89	0,98	0,74	0,30
Extracurricular education and out-of-school activities for children	8,94	10,03	11,01	13,43	12,58	13,17	10,22	4,23
Other institutions and activities in the field of education	5,73	6,61	8,03	11,88	7,39	11,95	8,18	6,22
Total	165,71	187,10	199,43	249,08	232,25	248,19	187,13	82,48

Source: calculated by the author according to Open Budget (2024)

Until 2013, Ukraine showed an upward trend in R&D expenditures, which dropped due to the economic downturn in 2014-2015, followed by a recovery in expenditure dynamics until 2021. In 2022, due to the war, R&D expenditures, in general, decreased to UAH 17117.8 million, with the most significant decrease in funding for basic research and scientific and technical developments, the volume of expenditures for which was generally the highest in 2010-2023 (the share of expenditures was 20.7% and 49.6% in 2023, respectively). In 2023, the funding of R&D in Ukraine was restored to UAH 21348.1 million, while the knowledge intensity of Ukraine's GDP decreased from 0.75% in 2010 to 0.33% in 2023 (Table 3).

Table 3.
Dynamics of research and development expenditures in Ukraine by type of work in 2010-2023, UAH million

Indicator	2010	2019	2020	2021	2022	2023	Deviation, +/-
Expenditure on research and development - total, UAH million	8107,1	17254,6	17022,4	20973,8	17117,8	21348,1	13241
fundamental scientific research	2175,0	3740,4	4259,0	5163,7	4081,3	4424,4	2249,4
in %	26,8	21,7	25,0	24,6	23,8	20,7	-6,1
applied scientific research	1589,4	3635,7	3971,4	4821,3	4827,6	6348,4	4759
in %	19,6	21,1	23,3	23,0	28,2	29,7	10,1
scientific and technical (experimental) developments	4342,7	9878,5	8792,1	10988,8	8208,9	10575,3	6232,6
in %	53,6	57,2	51,7	52,4	48,0	49,6	-4
Share of research and development expenditure in GDP, %	0,75	0,43	0,41	0,38	0,33	0,33	-0,42

Source: State Statistics Service (2024a)

At the same time, in 2022, the amount of R&D funding in all sectors decreased: business, public, and higher education. In 2023, compared to 2022, the share of R&D funding from the business sector increased from 54.1% to 59.1%. At the same time, the share of public sector R&D expenditures decreased from 37.5% to 33.5% (Figure 1).

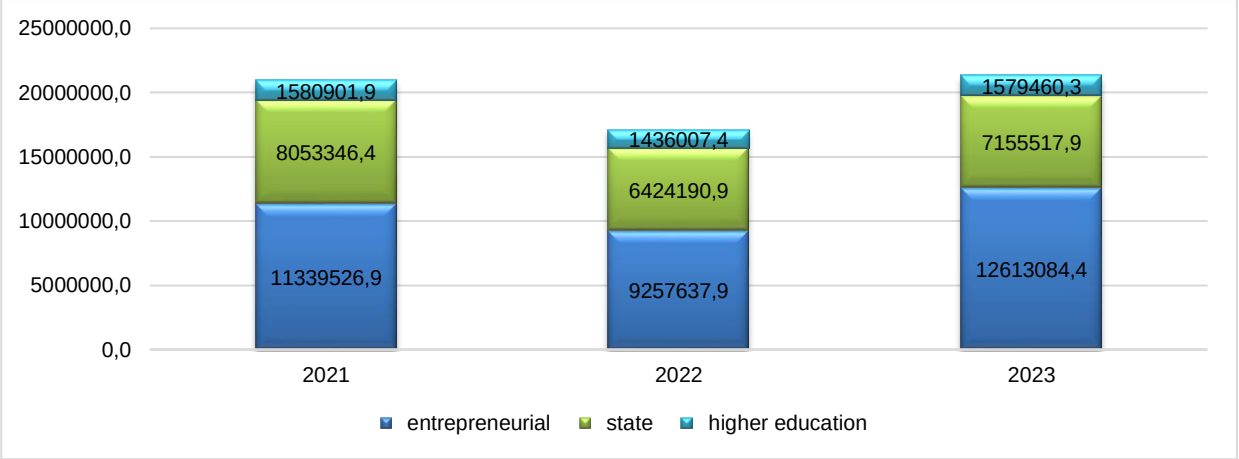

Figure 1. Ukraine's R&D expenditures by sector in 2021-2023, UAH million/%
Source: State Statistics Service (2024a)

In 2022, the predominant sources of funding for R&D expenditures in the business sector were public sector organisations (UAH 4,580.3 billion), business sector organisations (UAH 1,684.5 billion), foreign sources of R&D funding (UAH 1,597.1 billion), and own funds (UAH 1,289.1 billion).

For comparison, in EU countries, the share of R&D expenditure by funding source in 2021 was 57.7% from the business sector, 30.3% from the public sector, and 9.7% from foreign funds (Eurostat, 2024b).

An analysis of R&D expenditure by source of funding shows that more than half (57.7%) of total expenditure in the EU in 2021 was funded by enterprises, while almost a third (30.3%) was funded by the government, and another 9.7% from the rest of the world (foreign funds). Funding from the higher education sector was relatively small in 2021, at 1.2% of the total. The main change between 2011 and 2021 was a drop in the share of government funding from 33.6% in 2011 to 29.3% in 2019, with a slight increase in 2020 and then to 30.3% in 2021.

In 2023, the volume and share of such sources of financing R&D expenditures as enterprises' funds (UAH 5493.9 billion) and funds from foreign sources (UAH 3066.3 billion) increased significantly. At the same time, funding from public sector organisations decreased to UAH 2044.0 billion, while funding from the business sector increased to UAH 1981.4 billion (Figure 2).

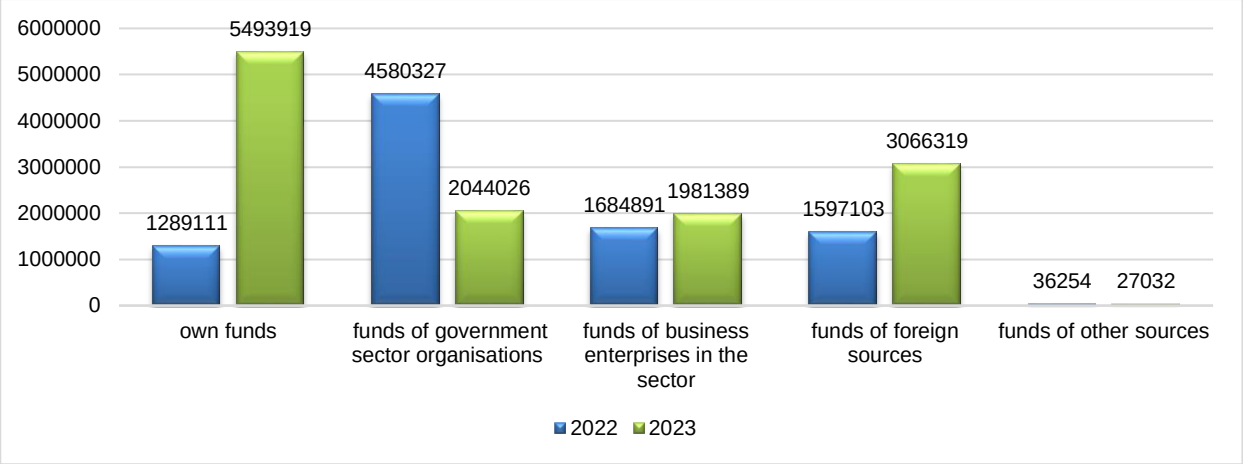

Figure 2. R&D expenditures of Ukraine's business sector by funding sources in 2022-2023, UAH million. Source: State Statistics Service (2024b)

By field of science, the largest amounts of funding in Ukraine are allocated to R&D in engineering and technology (almost 54% in 2021, 51% in 2023) and natural sciences (29% in 2021, 34% in 2023). Instead, insignificant amounts of funding are allocated to R&D in the fields of medical sciences (4.3% in 2021, 3% in 2023), agricultural sciences (almost 6% in 2021, 5.4% in 2023), social sciences, and humanities (Table 4).

Table 4.
Expenditures on research and development in Ukraine by field of science in 2021-2023, UAH million/%

In total	Volumes, UAH million			Specific gravity, %		
	2021	2022	2023	2021	2022	2023
Expenditures on research and development, total UAH million	20973775,2	17117836,2	21348062,6	100,00	100,00	100,00
Natural sciences, UAH million	6128799,1	4568181,2	7264362,5	29,22	26,69	34,03
Engineering and technology, UAH million	11293004,0	9477893,1	10866168,8	53,84	55,37	50,90
Medical and health sciences, UAH million	905458,1	668495,9	657679,9	4,32	3,91	3,08
Agricultural and veterinary sciences, UAH million	1213509,9	1057423,3	1160269,5	5,79	6,18	5,44
Social sciences, UAH million	946370,6	862488,6	919399,0	4,51	5,04	4,31
Humanities and arts, UAH million	486633,5	483354,1	480182,9	2,32	2,82	2,25

Source: State Statistics Service (2024c)

Despite the challenging conditions of wartime in Ukraine, since the beginning of the war in 2022, the actual volumes of funding for education from the state budget and throughout 2023–2025 have slightly decreased. A similar trend is observed with expenditures from local budgets directed towards financing the education sector. It should be noted that the planned volumes of expenditures on education and science are significantly lower than the actual ones. Additionally, there is a decline in the volumes of funding for the education and research sector relative to GDP.

Conclusions

Despite expectations of a reduction in funding for the education and research sector in the context of a full-scale war, the study demonstrates the ability of the government and local authorities to provide financial support for this sector. At the same time, expenditures on education and science in general decreased only in 2022. Instead, in 2023-2025, according to the State Statistics Service, the planned amount of state budget expenditures will increase in education and science funding in Ukraine. Educational services are generally funded from local budgets as a result of the decentralisation reform. The largest share of funds from the state budget is allocated to higher education institutions. Instead, preschool and secondary education are mainly financed by local budgets. In general, there is a decrease in the share of state budget expenditures on education, although their volumes are growing. In the structure of educational funding, the primary expenditures are allocated to preschool, general secondary, vocational pre-tertiary, and higher education. The government and local authorities in Ukraine should reconsider the distribution of expenditures, particularly to increase funding for the material and technical base of vocational education institutions and expand state-funded places for students in vocational institutions. This is linked to Ukraine's future post-war needs for skilled workers in vocational professions. The knowledge intensity of Ukraine's GDP is also declining with the growth of funding for the research sector. At the same time, funding for the scientific sector mainly depends on the business sector. Funds are mostly allocated to natural sciences, engineering, and technology.

During the war, the financial stability of the educational sector in Ukraine has been evident. However, the scientific sector, traditionally receiving the lowest funding in Ukraine compared to European countries, was forced to cease its activities in conducting fundamental and applied research in 2022, with slight recovery observed in 2023. Considering the ongoing conflict and significant wartime risks for Ukraine, state policy during the post-war recovery period should focus on stimulating the educational and scientific sector, particularly through increased funding for research and development (R&D) in higher education institutions from the state budget.

The primary limitations of this study are related to the lack of complete data on the financing of education by function through local budget expenditures, considering the decentralization process in Ukraine that began in 2015. The "Open Budget" platform, however, contains data on educational expenditures only since 2018.

Future research should focus on studying the efficiency of educational and scientific expenditures during conflict and the correlation of these expenditures with the quality of educational services during crises in Ukraine. Currently, similar studies are hindered by the absence of data on the performance indicators of educational institutions. For example, data on expenditures per student under state contracts are available only for 2020.

Bibliographic references

Agasisti, T., & Bertoletti, A. (2022). Higher education and economic growth: A longitudinal study of European regions 2000–2017. *Socio-Economic Planning Sciences*, *81*, 100940. https://doi.org/10.1016/j.seps.2020.100940

Androniceanu, A. M., Kinnunen, J., Georgescu, I., & Androniceanu, A. (2020). A Multidimensional Approach to Competitiveness, Innovation and Well-Being in the EU Using Canonical Correlation Analysis. *Journal of Competitiveness*, *12*(4), 5–21. https://doi.org/10.7441/joc.2020.04.01

Ansell, B. W., & Lindvall, J. (2015). The political origins of primary education systems: Ideology, institutions, and interdenominational conflict in an era of nation-building. *American Political Science Review*, *107*(3), 505-522. https://doi.org/10.1017/S0003055413000257

Blanco, F. A., Delgado, F. J., & Presno, M. J. (2020). R&D expenditure in the EU: Convergence or divergence? *Economic research*, *33*(1), 1685–1710. https://doi.org/10.1080/1331677X.2020.1756371

Busu, M., Nedelcu, C., & Cadis, A. (2021). An overview of the academic level among EU countries. A cluster analysis approach. In *Proceedings of the International Conference on Business Excellence, 15*(1), 210–217. https://doi.org/10.2478/picbe-2021-0020

Cantwell, B. (2021). Ideas for theorising the geopolitics of higher education in the global rankings era. In *Research Handbook on University Rankings.* (pp. 354–365). Edward Elgar Publishing. https://doi.org/10.4337/9781788974981.00038

Celli, V., Cerqua, A., & Pellegrini, G. (2024). Does R&D expenditure boost economic growth in lagging regions? *Social Indicators Research*, *173*, 249–268. https://doi.org/10.1007/s11205-021-02786-5

Chattopadhyay, S. (2007). Exploring alternative sources of financing higher education. *Economic and Political Weekly, 42*(42), 4251–4259.

Estermann, T., & Pruvot, E. B. (2015). University autonomy in Europe: The scorecard 2015. *European Journal of Education, 3*, 28-32. https://uned.kneu.edu.ua/wp-content/uploads/6_Estermann.pdf?utm_source=chatgpt.com

Eurostat (2024a). R&D expenditure. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure

Eurostat (2024b). R&D expenditure by source of funds. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure#R.26D_expenditure_by_source_of_funds

Goldrick-Rab, S., & Steinbaum, M. (2014). Redefining college affordability: The economics of financial aid. *Review of Educational Research, 88*(5), 649–688. https://www.luminafoundation.org/files/publications/ideas_summit/Redefining_College_Affordability.pdf

Hedges, L. V., & Rhoads, C. (2016). The state of the art in educational research. *Review of Research in Education, 40*(1), 1–27. https://www.ipr.northwestern.edu/documents/expert-cvs/Hedges-L_CV.pdf

Jongbloed, B. W. A., & Vossensteyn, H. (2016). Funding the university: Balancing efficiency and equity. *Oxford Review of Economic Policy, 32*(4), 576-595, https://doi.org/10.1093/oxrep/grw029

Krstić, M., Filipe, J. A., & Chavaglia, J. (2020). Higher Education as a Determinant of the Competitiveness and Sustainable Development of an Economy. *Sustainability*, *12*(16), 6607. https://doi.org/10.3390/su12166607

Law of Ukraine No. 280/97-VR. "On Local Self-Government in Ukraine" *Bulletin of the Verkhovna Rada of Ukraine (VVR)* of 15.11.2024. 1997, No. 24, p. 170. https://zakon.rada.gov.ua/laws/show/280/97-вр#Text

Lee, J. J. (Ed.). (2021). International higher education as geopolitical power. In *US power in international higher education*. pp. 1–20. Rutgers University Press. https://doi.org/10.2307/j.ctv1n6pvs6.3

Lung, M., Moldovan, I., & Alexandra, N. L. (2012). Financing higher education in Europe: issues and challenges. *Procedia-Social and Behavioural Sciences*, *51*, 938–942.

Marginson, S. (2016). The worldwide trend to high participation higher education: Dynamics of social stratification in inclusive systems. *Higher Education, 72,* 413–434. https://doi.org/10.1007/s10734-016-0016-x

Maringe, F. (2023). The conceptual 'jungle'of the decolonisation of Higher Education: Contestations, contradictions, and opportunities. In *Colonization and Epistemic Injustice in Higher Education* (pp. 1-22). Routledge. https://acortar.link/aa9FWg

McGuinness, A. C. (2016). State policy leadership for higher education: Past, present, and future. *Journal of Higher Education Policy and Management, 38*(5), 495–508.

Ministry of Education and Science of Ukraine. (November 19, 2024). *UAH 194.3 billion allocated to finance education and science in 2025*. https://mon.gov.ua/news/1943-mlrd-hrn-vydileno-na-finansuvannia-osvity-i-nauky-u-2025-rotsi

Mintz, B. (2021). Neoliberalism and the crisis in higher education: The cost of ideology. *American Journal of Economics and Sociology, 80*(1), 79–112. https://doi.org/10.1111/ajes.12370

OECD (2022). *Financing education: Trends and challenges*. Education at a Glance. Paris: OECD Publishing.

Open Budget (2024). *Análisis de IMPULSO*. Gastos. https://openbudget.gov.ua/analytics/expenses

Pellegrini, M., & Vivanet, G. (2021). Evidence-based policies in education: Initiatives and challenges in Europe. *ECNU Review of Education, 4*(1), 25–45. https://doi.org/10.1177/2096531120924670

Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. *Education Economics, 26*(5), 445–458. https://doi.org/10.1080/09645292.2018.1484426

Rizvi, F., & Lingard, B. (2015). Globalising education policy. *Journal of Education Policy, 30*(4), 551–563. https://doi.org/10.4324/9780203867396

Sá, C. M., & Sabzalieva, E. (2018). The politics of the great brain race: public policy and international student recruitment in Australia, Canada, England and the USA. *Higher Education, 75*, 231–253. https://doi.org/10.1007/s10734-017-0133-1

Scott, P. (2015). Universities and the knowledge economy: Past, present, and future. *European Review, 43(3*), 297-309. http://dx.doi.org/10.1007/s11024-005-6510-4

Simionescu, M., Pelinescu, E., Khouri, S., & Bilan, S. (2021). The Main Drivers of Competitiveness in the EU-28 Countries. *Journal of Competitiveness, (1).* https://doi.org/10.7441/joc.2021.01.08

State Statistics Service (2024a). *Expenditures on research and development by type of work (2010–2023)*. https://ukrstat.gov.ua/operativ/menu/menu_u/ni.htm

State Statistics Service (2024b). *Expenditures on research and development by sectors of activity (2021–2023)*. https://ukrstat.gov.ua/operativ/menu/menu_u/ni.htm

State Statistics Service (2024c). *Expenditures on research and development of enterprises in the business sector with a breakdown by sources of funding and number of employees (2023)*. https://ukrstat.gov.ua/operativ/menu/menu_u/ni.htm

Teixeira, P., & Dill, D. D., (2000). Program diversity in higher education: an economic perspective. *Higher Education Policy*, *13*, 99-117. https://doi.org/10.1016/S0952-8733(99)00026-4

Vorontsova, A. S., Vasylieva, T. A., Bilan, Y. V., Ostasz, G., & Mayboroda, T. (2020). The influence of state regulation of education for achieving the sustainable development goals: a case study of Central and Eastern European countries. *Administratie si Management Public, 34,* 6-26. https://acortar.link/X96ZaP

Ziderman, A. (2017). Student loans in tertiary education: Their role and global trends. *Education Economics, 25*(1), 2–19. https://acortar.link/6Ay21D

DOI: https://doi.org/10.46502/issn.1856-7576/2024.18.04.20
Cómo citar:
Rojas-Bahamon, M.J., & Arbeláez-Campillo, D.F. (2024). Medios digitales y su impacto en la salud mental y la identidad. *Revista Eduweb*, *18*(4), 297-310. https://doi.org/10.46502/issn.1856-7576/2024.18.04.20

Medios digitales y su impacto en la salud mental y la identidad

Digital media and its impact on mental health and identity

Magda Julissa Rojas-Bahamon
https://orcid.org/0000-0003-4882-1476
mjulissa@gmail.com
Ph.D. Educación y cultura ambiental, MsC. Ciencias de la Educación, Esp. Seguridad de la Información, Esp. Pedagogía. Docente IE Jorge Eliécer Gaitán. Grupo de Investigación Primmate Colciencias, Colombia.
Diego Felipe Arbeláez-Campillo
https://orcid.org/0000-0002-9041-9563
dfaca@hotmail.com
MsC. Ciencias de la Educación. Grupo de Investigación Lenguajes, Representaciones y Educación, Universidad de la Amazonia, Colombia.

Recibido: 03/10/24
Aceptado: 12/12/24

Resumen

La omnipresencia de la información digital ha transformado la forma en que los jóvenes interactúan con los medios y construyen su identidad. Esta realidad plantea desafíos, como la diseminación de noticias falsas y el impacto en la salud mental. El presente estudio explora la relación entre los estudiantes de educación media en Colombia y la era digital, con el objetivo de comprender cómo navegan en el vasto océano de información digital y cómo esto influye en su alfabetización mediática, salud mental e identidad en el entorno escolar. Se empleó una metodología mixta, combinando encuestas y entrevistas para recopilar datos sobre hábitos de consumo de medios, percepciones de identidad y experiencias relacionadas con el bienestar mental. Los resultados revelaron una brecha en la capacidad de los estudiantes para discernir la veracidad de la información y gestionar la presión de presentar una autoimagen ideal en línea. Además, se observó una prevalencia de sentimientos de estrés y ansiedad asociados con el uso de medios digitales. Se concluye que es crucial implementar una educación mediática sólida en los currículos escolares para equipar a los jóvenes con las habilidades necesarias para interactuar de manera crítica y saludable con los medios digitales en la era moderna.

Palabras Clave: Influencia de los medios, alfabetización mediática, salud mental, identidad, análisis de redes sociales, currículo escolar.

Abstract

The ubiquity of digital information has transformed the way young people interact with media and construct their identities. This reality poses challenges, such as the dissemination of fake news and the impact on mental health. This study explores the relationship between middle school students in Colombia and the digital age, aiming to understand how they navigate the vast ocean of digital information and how this influences their media literacy, mental health, and identity in the school environment. A mixed methodology was employed, combining surveys and interviews to collect data on media consumption habits, identity perceptions, and experiences related to mental well-being. The results revealed a gap in students' ability to discern the veracity of information and

manage the pressure to present an ideal online self-image. Furthermore, a prevalence of feelings of stress and anxiety associated with the use of digital media was observed. It is concluded that it is crucial to implement robust media education in school curricula to equip young people with the skills necessary to interact critically and healthily with digital media in the modern era.

Keywords: Media influence, media literacy, mental health, identity, social network analysis, school curriculum.

Introducción

El ser humano vive en una era en la que la información digital es omnipresente y tiene el poder de moldear percepciones, comportamientos y sociedades. Esta realidad es alimentada por la naturaleza interconectada del mundo globalizado y la proliferación de plataformas digitales que hacen que la comunicación sea más accesible que nunca (Couldry & Hepp, 2017). En este entorno digital, la velocidad sin precedentes con la que se distribuye la información —veraz o no— tiene el potencial de influenciar a audiencias globales en tiempos extremadamente cortos (Vosoughi, Roy & Aral, 2018). Esta omnipresencia de la información, sin embargo, viene con sus desafíos.

La diseminación de noticias falsas o 'fake news' ha resaltado la urgencia de una alfabetización mediática efectiva, ahora considerada una competencia esencial en el paisaje digital del siglo XXI (Hobbs, 2010). Junto con esto, el análisis de medios y contenido digital se ha vuelto más relevante, con la necesidad de identificar y comprender los sesgos en la información en un pico histórico (Wardle & Derakhshan, 2017).

Más allá de la veracidad y el sesgo, los desafíos presentados por los medios digitales se extienden al ámbito de la salud mental. Hay una creciente base de evidencia que sugiere preocupaciones sobre el impacto de la interacción intensiva con medios digitales en la salud mental y emocional de las personas, especialmente entre los jóvenes (Twenge & Campbell, 2018). Paralelamente, se ha observado cómo los medios digitales influyen en la formación de identidades, donde se presentan tanto oportunidades para la autoexpresión como riesgos asociados a la percepción de uno mismo (Manago et al., 2008).

En este contexto, es imperativo abordar estos temas desde una perspectiva investigativa. En la presente investigación, se exploran estos asuntos críticos mediante una combinación de revisión literaria y datos primarios. Al adoptar una metodología mixta, se aspira a comprender mejor la intersección entre medios digitales, salud mental e identidad, y cómo estos elementos configuran las experiencias en el mundo digital contemporáneo.

Medios Digitales

Los medios digitales son plataformas y herramientas electrónicas que permiten la distribución, creación y consumo de información de manera digital (Lister et al., 2008). Ejemplos claros de medios digitales incluyen sitios web, aplicaciones móviles, redes sociales como Facebook y Twitter, y plataformas de video como YouTube. Estos medios no solo son portadores de información, sino también facilitadores de interacción entre usuarios de diversas partes del mundo.

De acuerdo con Rojas-Bahamón (2012) una característica clave de los medios digitales es su interactividad, permitiendo una comunicación bidireccional. Son adaptables, personalizables y tienen la capacidad de proporcionar contenido en tiempo real, dependiendo de la interacción del usuario. Esta interactividad y adaptabilidad los hacen especialmente atractivos y efectivos en captar la atención del público.

Dada la influencia penetrante de los medios digitales en la vida cotidiana, se han convertido en una herramienta esencial en la definición de prácticas culturales y en la formación de opiniones. En contextos democráticos, pueden alterar cómo se practica la ciudadanía y cómo interactúan las sociedades. La

facilidad con la que se puede acceder y difundir información a través de estos medios les otorga un poder sin precedentes en la sociedad contemporánea.

Dentro del entorno educativo, los medios digitales han revolucionado los métodos de enseñanza y aprendizaje. Ofrecen nuevas modalidades pedagógicas, facilitan el acceso a recursos educativos y fomentan la colaboración y comunicación entre estudiantes y docentes. Sin embargo, también presentan desafíos, como la necesidad de una alfabetización digital adecuada para discernir información confiable.

Salud Mental

La salud mental se define como un estado en el cual el individuo es consciente de sus propias habilidades, puede enfrentar las tensiones normales de la vida, trabajar de manera productiva y es capaz de hacer una contribución a su comunidad (OMS, 2018). Más allá de la ausencia de afecciones o enfermedades mentales, la salud mental abarca el bienestar emocional, psicológico y social del individuo.

Una buena salud mental es crucial para mantener una calidad de vida adecuada, pues impacta directamente en la capacidad de un individuo para realizar actividades diarias, establecer relaciones saludables y contribuir de manera efectiva a la sociedad. Es un componente esencial para el desarrollo personal y profesional de cualquier individuo.

El papel que desempeña la salud mental en el contexto educativo no puede ser subestimado. Los estudiantes con buen bienestar mental tienen una mejor capacidad para concentrarse, comprender y retener información. Esto, a su vez, mejora su rendimiento académico y sus interacciones sociales.

Dentro del entorno escolar, es esencial reconocer y abordar los desafíos relacionados con la salud mental. Las presiones académicas, las interacciones sociales y, en el contexto actual, la influencia de los medios digitales, pueden impactar el bienestar mental de los estudiantes. La promoción de ambientes de aprendizaje saludables y el apoyo psicológico son esenciales para garantizar el éxito educativo.

Identidad

La identidad se refiere al conjunto de características, creencias, deseos y experiencias que definen a un individuo. Es una construcción que se forma y reforma a lo largo del tiempo, influenciada por interacciones personales, experiencias y contextos culturales (Turkle, 1999).

Las características de la identidad son múltiples y multifacéticas. Estas incluyen, pero no se limitan a rasgos personales, afiliaciones culturales, creencias religiosas y orientaciones sexuales. Es una combinación de cómo los individuos se ven a sí mismos, cómo desean ser vistos y cómo son percibidos por otros. La identidad también se moldea y refleja a través de las elecciones y comportamientos diarios de una persona.

La identidad juega un papel crucial en la formación de relaciones, la construcción de comunidades y la navegación a través de diferentes contextos sociales y culturales. Es esencial para la autocomprensión y el establecimiento de relaciones interpersonales saludables.

En el ámbito educativo, la construcción de la identidad es un proceso continuo. Los estudiantes no solo aprenden conceptos académicos, sino que también exploran y definen quiénes son en relación con sus compañeros, educadores y comunidades. Los entornos escolares pueden ser lugares donde la identidad se refuerza, se desafía o se transforma. En este sentido, es fundamental que las instituciones educativas proporcionen un espacio seguro y de apoyo para la exploración y afirmación de la identidad.

Materiales y métodos

El enfoque metodológico adoptado en este estudio es de naturaleza mixta, combinando análisis cuantitativo y cualitativo para proporcionar una visión comprensiva y enriquecedora de los temas investigados. A continuación, se detallan los pasos metodológicos seguidos:

Recolección de datos

Para obtener datos se llevó a cabo la recolección de información a través de encuestas y entrevistas. La población de estudio consistió en estudiantes de educación básica y media de una institución educativa de carácter público en Colombia. Se realizó una encuesta en línea para recopilar datos cuantitativos. El instrumento involucró preguntas cerradas y abiertas, distribuida a todos los estudiantes de la institución. Adicionalmente, se llevaron a cabo entrevistas semiestructuradas con una selección de estudiantes para profundizar en las percepciones y experiencias de los participantes con respecto a los medios digitales.

Determinación del tamaño de muestra

Para garantizar que los resultados obtenidos sean representativos y confiables, se procedió a calcular el tamaño de muestra requerido para la recopilación de datos primarios a través de encuestas y entrevistas. El cálculo del tamaño de muestra se basó en un nivel de confianza del 95% y un margen de error del 5%.

La fórmula utilizada para calcular el tamaño de muestra en una población finita es la siguiente:

$$n = \frac{N * Z^2 * p * (1 - p)}{N * E^2 + Z^2 * p * (1 - p)}$$

Donde:

n es el tamaño de muestra necesario.
N es el tamaño total de la población.
Z es el valor crítico de la distribución normal correspondiente al nivel de confianza deseado.
p es la estimación de la proporción de la población con la característica de interés.
E es el margen de error permitido.

Para este estudio, con una población total de N=418 estudiantes, se eligió un nivel de confianza del 95% y un margen de error del 5%. El valor de Z para un nivel de confianza del 95% es aproximadamente 1.96. Dado que no se disponía de una estimación precisa p, se utilizó un valor conservador de p=0.5 para maximizar el tamaño de muestra.

Sustituyendo estos valores en la fórmula, se calculó un tamaño de muestra mínimo requerido de n≈385 participantes. El cálculo de tamaño de muestra se realizó con el propósito de asegurar que los datos recopilados sean estadísticamente válidos y representativos de la población estudiantil en el contexto de estudio. No obstante, en este estudio participaron 418 estudiantes.

Análisis de datos

Los datos cuantitativos recogidos a través de la encuesta se graficaron en una hoja de cálculo. Por otro lado, los datos cualitativos obtenidos de las entrevistas y del análisis de contenido se analizaron temáticamente para identificar patrones y tendencias.

Se empleó el software NVivo para realizar un análisis de contenido de las respuestas cualitativas obtenidas de las entrevistas y otros datos cualitativos recopilados. NVivo facilitó la codificación y categorización eficiente de las respuestas, permitiendo la identificación de patrones, temas emergentes y palabras clave.

Además, se utilizaron herramientas de visualización disponibles en NVivo para crear nubes de palabras, que representaron gráficamente las palabras y conceptos más frecuentes y prominentes en las respuestas cualitativas. Este enfoque de análisis cualitativo asistido por software añadió profundidad y precisión al proceso de identificación de tendencias y significados subyacentes en los datos.

Integración de resultados

Los hallazgos cuantitativos y cualitativos se integraron para construir una narrativa en torno a los temas de estudio. Los resultados obtenidos de la revisión de la literatura, las encuestas, las entrevistas y el análisis de contenido fueron contrastados y comparados para generar la discusión del estudio.

El estudio fue aprobado por el comité de ética de la institución y todos los participantes proporcionaron su consentimiento informado. Se garantizó el derecho de los participantes a retirarse del estudio en cualquier momento y se aseguró que todos los datos recopilados se mantuvieran anónimos para preservar la privacidad y confidencialidad de los participantes.

Resultados y discusión

Los resultados de la encuesta y las entrevistas brindaron una visión amplia del uso de los medios digitales entre los estudiantes de educación básica y media en una institución educativa en Colombia, así como su influencia en la salud mental y la identidad.

Alfabetización mediática

La alfabetización mediática es la capacidad de comprender, analizar y evaluar los medios de comunicación. Es una habilidad esencial en el mundo actual, donde las personas están constantemente expuestas a mensajes de los medios de comunicación. La alfabetización mediática permite a las personas tomar decisiones informadas sobre los medios de comunicación, y utilizar los medios de comunicación para su propio beneficio.

En la investigación realizada, los resultados de la aplicación de instrumentos se establecieron para determinar la tendencia de uso, comprensión para evaluar la confiabilidad de las fuentes, la identificación de los sesgos en la información y confianza en interpretar y analizar mensajes digitales (Ver gráfica 1).

Figura 1. Alfabetización mediática en estudiantes de educación media.

Aunque el 80% de los estudiantes reportaron que usan medios digitales todos los días, solo el 40% demostró una comprensión clara de cómo evaluar la confiabilidad de las fuentes de información en línea. El 30% de los estudiantes pudo identificar regularmente los sesgos en la información en línea, y sólo el

20% reportó sentirse muy confiado en su capacidad para interpretar y analizar mensajes en los medios digitales.

Por otra parte, la información cualitativa en esta categoría permitió obtener la nube de palabras dispuesta en la figura 2.

Figura 2. Nube de palabras categoría Alfabetización mediática.

En esta categoría los términos con mayor frecuencia de aparición son 'Medios', 'Digital', 'Información', 'Confianza' y 'Sesgos'. Esto sugiere que el discurso se centra en la necesidad y los procesos de adquirir competencias y habilidades para navegar eficazmente en los medios digitales. La alfabetización mediática abarca el acceso, análisis, evaluación y creación de información en una variedad de formas de medios. Esto podría indicar una discusión en torno a la capacidad de los individuos para discernir información confiable y precisa de la que no lo es, así como reconocer y cuestionar los sesgos presentes en el contenido mediático.

La alta frecuencia de 'Interpretación', 'Análisis', 'Mensajes' y 'Conocimiento' sugiere un enfoque en el proceso de descomponer y comprender los mensajes transmitidos a través de los medios digitales. Esto podría involucrar la deconstrucción de estos mensajes para revelar sus significados ocultos y las intenciones de los creadores de contenido.

Las palabras 'Habilidades', 'Comunicación', 'Navegación', 'Crítica' y 'Diseminación' probablemente se refieren a las habilidades específicas necesarias para interactuar eficazmente con los medios digitales, incluyendo la capacidad de comunicar y compartir información de manera efectiva, y de buscar y seleccionar información de manera crítica y estratégica.

'Contenido', 'Fuentes', 'Herramientas', 'Redes sociales' y 'Tecnología' son términos que probablemente se refieren a los componentes concretos y canales de los medios digitales con los que los individuos interactúan y que deben aprender a manejar y a entender.

Las palabras 'Consumo', 'Cultura digital', 'Participación', 'Empoderamiento', 'Ética', 'Seguridad', 'Privacidad', 'Transparencia', 'Responsabilidad', 'Creación' y 'Curación' podrían ser discutidas en términos de cómo los individuos interactúan y participan en la cultura digital y cómo pueden hacerlo de manera segura, ética y responsable, a la vez que se empoderan para crear y curar su propio contenido.

De esta manera, el discurso en torno a la "Alfabetización mediática" parece centrarse en las habilidades y competencias necesarias para interactuar de manera efectiva y responsable con los medios digitales, en la capacidad de cuestionar y analizar críticamente el contenido mediático y en la importancia de ser un participante activo y consciente en la cultura digital. Los resultados indican que la mayoría de los estudiantes tienen una comprensión básica de los medios digitales. Sin embargo, su capacidad para discernir la veracidad de la

información y reconocer los sesgos fue limitada. Esta observación coincide con estudios anteriores que resaltan la necesidad de mejorar la alfabetización mediática y crítica en la era digital (Buckingham, 2007).

Hay muchos diferentes enfoques para la alfabetización mediática. Algunos autores enfatizan la alfabetización crítica, que es la capacidad de identificar y cuestionar los sesgos y los estereotipos en los medios de comunicación (Jenkins, 2009). Otros enfatizan la alfabetización creativa, que es la capacidad de utilizar los medios de comunicación para expresarse y para crear sus propios mensajes. Sin embargo, aunque existan estas diferencias conceptuales, es innegable determinar que la alfabetización mediática es importante por una serie de razones. En primer lugar, ayuda a las personas a ser ciudadanos informados. En un mundo donde las personas están constantemente bombardeadas con información, es importante ser capaz de evaluar la información de forma crítica. La alfabetización mediática permite a las personas identificar la información falsa y a tomar decisiones informadas sobre los temas que les importan.

En segundo lugar, la alfabetización mediática ayuda a las personas a ser consumidores más conscientes. En un mundo donde las personas están constantemente bombardeadas con publicidad, es importante ser capaz de identificar los mensajes publicitarios y a tomar decisiones informadas sobre los productos que compran. La alfabetización mediática permite a las personas identificar las técnicas de manipulación que utilizan los anunciantes, y a tomar decisiones informadas sobre los productos que compran.

En tercer lugar, la alfabetización mediática ayuda a las personas a ser ciudadanos más activos. En un mundo donde las personas están constantemente bombardeadas con mensajes políticos, es importante ser capaz de evaluar la información de forma crítica y a tomar decisiones informadas sobre los candidatos políticos, por eso, la alfabetización mediática permite a las personas identificar los mensajes políticos y a tomar decisiones informadas sobre los candidatos políticos.

Análisis de medios y contenido digital

La categoría "Análisis de medios y contenido digital" se enfoca en la creciente influencia y el impacto de los medios digitales, incluyendo las redes sociales, blogs, y diversas plataformas en línea, en la formación de la percepción y opinión pública. La categoría enfoca en la evaluación y examen crítico de los diversos medios de comunicación y sus contenidos, particularmente en el ámbito digital.

En la era digital actual, donde las redes sociales desempeñan un papel preponderante en la forma en que las personas acceden a la información, es esencial examinar la relación que los jóvenes, particularmente los estudiantes, tienen con estas plataformas. Estas herramientas, que comenzaron como simples medios de comunicación y socialización, ahora ejercen una influencia notable en la percepción y comprensión de eventos actuales y noticias por parte de este grupo demográfico. (Ver figura 3).

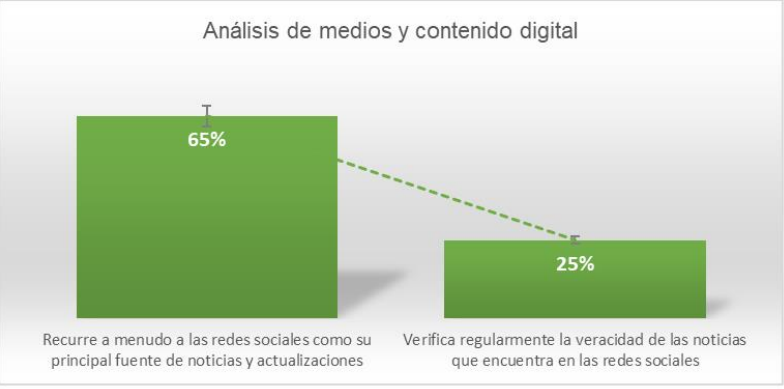

Figura 3. Análisis de medios y contenido digital en estudiantes de educación media.

Los datos determinaron que aproximadamente el 65% de los estudiantes reportó que recurre a menudo a las redes sociales como su principal fuente de noticias y actualizaciones. Así mismo, solo el 25% de los estudiantes indicó que verifican regularmente la veracidad de las noticias que encuentran en las redes sociales.

Este hallazgo es particularmente inquietante ya que destaca una posible vulnerabilidad de los estudiantes a la desinformación. Si bien las redes sociales pueden ser un medio rápido y accesible para obtener noticias, la falta de verificación de la información puede llevar a malentendidos y la propagación de noticias falsas. Esta situación pone de manifiesto la necesidad urgente de fomentar habilidades críticas y de alfabetización mediática entre los estudiantes para que puedan navegar de manera efectiva y responsable en el paisaje informativo de hoy.

Tras examinar las tendencias de consumo de información entre los estudiantes, es esencial visualizar los términos y conceptos más recurrentes asociados a esta temática. En la figura 4 presentamos una nube de palabras que destaca las palabras clave y conceptos que emergen con más frecuencia en relación con el análisis de medios y contenido digital. Esta visualización nos proporcionará una perspectiva clara de los términos dominantes y nos ayudará a comprender mejor el panorama general del comportamiento informativo de los jóvenes en la era digital.

Figura 4. Nube de palabras categoría análisis de medios y contenido digital.

En esta categoría, 'Medios' y 'Contenido' son las palabras con mayor frecuencia, lo que indica que el foco está en el estudio y el entendimiento de los medios de comunicación y su contenido. Específicamente, esto puede referirse a la evaluación de la calidad, la precisión, y la objetividad de la información presentada en los medios.

Las palabras 'Digital', 'Fuentes' y 'Veracidad' sugieren un enfoque en la evaluación de la fiabilidad y precisión de las fuentes de información en el ámbito digital. Esto puede implicar el análisis de la calidad de las fuentes de información y la veracidad de las noticias o información transmitidas.

'Noticias', 'Redes sociales', 'Sesgos', 'Información', 'Internet' y 'Publicaciones' son palabras que probablemente se refieren a los diversos tipos de contenido y plataformas de medios que son analizados. Esta podría ser una discusión sobre cómo las diferentes formas de medios y plataformas pueden sesgar la información o cómo pueden ser utilizadas para difundir noticias falsas o desinformación.

Las palabras 'Algoritmos', 'Datos', 'Blogs', 'Fake news', 'Propaganda', 'Desinformación' y 'Comentarios' sugieren una discusión sobre las diferentes formas en que la información puede ser manipulada o mal interpretada en los medios digitales. Esto puede involucrar el análisis de cómo los algoritmos de las

plataformas de medios sociales pueden influir en lo que los usuarios ven y cómo esto puede sesgar su percepción de la realidad.

'Usuarios', 'Interacciones', 'Viralidad', 'Plataformas', 'Imágenes', 'Tweets', 'Compartir', 'Vídeos', 'Likes', 'Clickbait', 'Hashtags', 'Influenciadores', 'SEO' y 'Memes' son términos que probablemente se refieren a las diversas formas en que los usuarios interactúan con el contenido de los medios digitales. Esto puede incluir la discusión de cómo estas interacciones pueden ser utilizadas para analizar tendencias, identificar sesgos y entender cómo se difunden los mensajes en las plataformas de medios digitales.

De esta manera, el discurso en torno al "Análisis de medios y contenido digital" parece estar centrado en la evaluación y el entendimiento crítico de los medios digitales y su contenido, la identificación de sesgos y la manipulación de la información, y el estudio de cómo los usuarios interactúan con este contenido.

Los estudiantes solían recurrir a fuentes de información que no siempre eran confiables. El análisis de contenido evidenció un uso frecuente de códigos y mensajes implícitos en los medios digitales, los cuales a menudo pasaban desapercibidos para ellos. Este hallazgo subraya la relevancia de fomentar la educación en análisis de medios (Lewandowsky, Ecker & Cook, 2017) y el desarrollo del pensamiento crítico. En este contexto, Arbeláez-Campillo et al. (2020) destacan que el pensamiento crítico juega un papel crucial en la participación y la deliberación, con repercusiones incluso en el ámbito político, al promover un discurso informado y razonado.

Impacto de los medios digitales en la salud mental y emocional

La categoría "Impacto de los medios digitales en la salud mental y emocional" aborda el efecto que los medios digitales pueden tener en el bienestar psicológico y emocional de las personas. Esta categoría puede explorar los riesgos y beneficios asociados con el uso de medios digitales y cómo estos pueden influir en factores como el estado de ánimo, la autoestima, la ansiedad, el estrés, la depresión y otros aspectos relacionados con la salud mental y emocional.

En la era digital actual, donde la información es vasta y constantemente accesible, es crucial comprender cómo los estudiantes perciben y gestionan el diluvio de contenido que encuentran en línea. Al considerar el comportamiento y las reacciones emocionales de los estudiantes ante el consumo de medios digitales, se descubrió que el 35% de ellos siente con frecuencia la sensación de estar abrumados debido a la profusa cantidad de información en línea. Además, preocupantemente, el 50% ha reportado síntomas de ansiedad o estrés que asocian directamente con el uso de dichos medios. (ver figura 5).

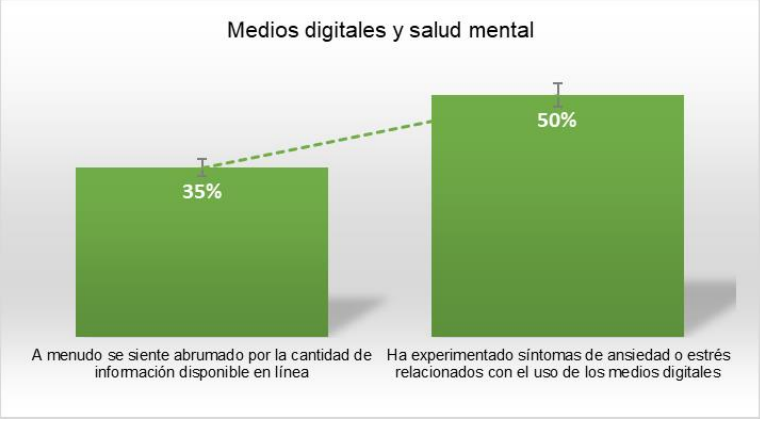

Figura 5. Medios digitales y salud mental en estudiantes de educación media.

El análisis de estos datos sugiere que la navegación en el vasto océano de información digital no está exenta de desafíos emocionales para los estudiantes. La sensación de saturación informativa, evidenciada

por el 35% de los encuestados, puede ser indicativa de la necesidad de implementar estrategias de gestión de información y habilidades de alfabetización digital más efectivas en el ámbito educativo. Además, el hecho de que la mitad de los estudiantes haya experimentado síntomas de malestar emocional relacionados con el uso de medios digitales subraya la importancia de abordar la salud mental y el bienestar en el contexto de la educación digital. Estas cifras nos instan a reconsiderar cómo se está preparando a los estudiantes para enfrentar y gestionar la abrumadora cantidad de información y las posibles repercusiones emocionales derivadas de su consumo.

Para visualizar de manera más intuitiva y concisa las principales palabras y conceptos relacionados con la experiencia de los estudiantes en el entorno digital y su impacto emocional, se ha preparado un mapa de nube de palabras (Ver figura 6). Esta herramienta gráfica refleja las terminologías y temas que surgen con mayor frecuencia en relación con el tema abordado. Este análisis examina una serie de términos que son relevantes para el impacto de los medios digitales en la salud mental y emocional de las personas. Estos términos abarcan una gama de temas que van desde los desafíos psicológicos, como el estrés y la ansiedad, hasta los comportamientos relacionados con el uso de los medios digitales, como el uso excesivo y la adicción.

Figura 6. Nube de palabras categoría Medios digitales y salud mental en estudiantes de educación media

Según la frecuencia de aparición de los términos proporcionados, el discurso se centra en gran medida en la "salud mental", "emociones", "ansiedad", "estrés" y "sobrecarga". Esto señala la atención centrada en el impacto que tienen los medios digitales y las redes sociales en la salud mental y emocional de los individuos.

"Salud mental" y "emociones", como los términos más frecuentes, indican que la conversación en torno a los medios digitales a menudo se centra en su impacto en la psicología y el estado emocional de las personas. Un gran cuerpo de investigación ha señalado las consecuencias negativas potenciales del uso excesivo de los medios digitales para la salud mental, incluyendo el aumento de la ansiedad y el estrés, la disminución del bienestar emocional, y una serie de otros problemas de salud mental (Twenge et al., 2017).

El término "ansiedad" es otro foco central en este análisis, lo que refleja las preocupaciones documentadas en la literatura científica acerca de cómo el uso de los medios digitales puede fomentar sentimientos de ansiedad. Esto puede ser debido a una serie de factores, como la presión para estar constantemente disponible, la comparación social, o la sobrecarga de información (Vannucci & McCauley Ohannessian, 2019).

Además, el término "estrés" también es prominente, lo que refleja el reconocimiento de que los medios digitales pueden ser una fuente de estrés. Esto puede ser debido a la sobrecarga de información, la presión para mantener una presencia en línea, o el estrés de tratar con interacciones negativas en línea, como el ciberacoso (Best, Manktelow & Taylor, 2014).

El término "sobrecarga" es otro que ocupa un lugar destacado en la conversación, reflejando la preocupación por la cantidad de información a la que los usuarios de los medios digitales están expuestos y la dificultad de procesarla (Misra & Stokols, 2012).

Mientras tanto, otros temas importantes como "uso", "redes sociales", "depresión", "bienestar" y "autoestima" también son prominentes en el discurso, destacando su relevancia en la discusión del impacto de los medios digitales en la salud mental y emocional.

Este análisis resalta el hecho de que la conversación sobre el impacto de los medios digitales en la salud mental y emocional está dominada por preocupaciones sobre los efectos negativos potenciales, incluyendo el aumento de la ansiedad y el estrés, y la sobrecarga de información. Esto refleja el creciente cuerpo de evidencia en la literatura científica que destaca estos problemas. Sin embargo, también es importante destacar que los medios digitales también pueden tener beneficios para la salud mental y emocional, como proporcionar formas de conexión y apoyo social, y estas áreas también merecen más atención en la conversación.

Formación de identidades y autoimagen en entornos digitales

La categoría "Formación de identidades y autoimagen en entornos digitales" se centra en el impacto de los medios digitales y las plataformas de redes sociales en la creación y percepción de la identidad personal y la autoimagen. En la era digital, los individuos tienen la oportunidad de expresarse, compartir y formar sus identidades de formas nuevas y variadas, a veces enfrentándose a desafíos únicos.

En la era digital actual, donde las plataformas en línea desempeñan un papel crucial en la socialización y el desarrollo personal, es imperativo comprender cómo los jóvenes interactúan y se perciben a sí mismos en estos entornos. Este estudio reveló que una abrumadora mayoría de estudiantes se aventura en los medios digitales no solo como consumidores de contenido, sino como exploradores activos y creadores de su propia identidad.

Este hallazgo, aunque prometedor en términos de autoexploración y autodefinición, viene con ciertas implicaciones. A pesar de que un 70% de los encuestados reconocen los medios digitales como un espacio para la autoexpresión, un 60% siente la carga de representar una "autoimagen ideal". Esto sugiere una dinámica compleja: mientras que los medios digitales ofrecen oportunidades sin precedentes para la exploración de la identidad, también imponen una presión considerable sobre los individuos para adherirse a normas o estándares potencialmente poco realistas, lo que puede tener repercusiones en el bienestar emocional y psicológico de los jóvenes.

Así mismo, a fin de visualizar de manera más clara y sintética las principales temáticas y preocupaciones relacionadas con la interacción de los estudiantes en los medios digitales y su autoimagen, a continuación, se presenta un mapa de nube de palabras. Este gráfico resalta los términos y conceptos más recurrentes, ofreciendo una perspectiva instantánea de los puntos clave en torno a este fenómeno contemporáneo. (Ver figura 7).

Figura 7. Mapa de nube Formación de identidades y autoimagen en entornos digitales.

La "digital" y la "autoimagen" son las palabras de mayor frecuencia y constituyen el núcleo de esta categoría. El entorno digital, particularmente las "redes sociales", proporcionan un espacio para la "autoexpresión", permitiendo a las personas presentar una "imagen" idealizada de sí mismas en sus "perfiles" (Zhao et al., 2008). Sin embargo, esta capacidad de controlar la auto-presentación en línea a veces puede generar "presión" para cumplir con un "ideal". El término "comparación" también resalta la tendencia de los individuos a compararse con los "influenciadores" y otros usuarios de las redes sociales, lo que puede afectar negativamente la "autoimagen" y la "percepción" de uno mismo (Fardouly et al., 2015).

La "autenticidad", "privacidad" y la "marca personal" son aspectos importantes de la gestión de la identidad en línea. Al mismo tiempo, la existencia de "trolls" y el "ciberbullying" son desafíos a los que se pueden enfrentar los usuarios de las redes sociales (Kowalski et al., 2014).

El "feedback" en forma de "likes", "comentarios" y la cantidad de "seguidores" puede repercutir significativamente en la autoestima y la percepción de uno mismo. La ansiedad de "FOMO" (miedo a perderse algo) es otro fenómeno digital que puede influir en la autoimagen y las relaciones en línea (Przybylski et al., 2013).

De esta manera, podemos deducir que el entorno digital ofrece oportunidades únicas para la autoexpresión y la construcción de identidad, pero también presenta desafíos como la presión para cumplir con ideales específicos, el ciberbullying y la ansiedad relacionada con la percepción de uno mismo y la aceptación social.

En el estudio se pudo determinar que los estudiantes también informaron sobre los aspectos positivos de los medios digitales, como la posibilidad de expresarse y explorar diferentes aspectos de su identidad. Sin embargo, también surgieron preocupaciones sobre la presión para presentar una "autoimagen ideal" en línea, lo que confirma estudios previos que han resaltado esta preocupación (Manago et al., 2008).

Conclusiones

La convergencia de los medios digitales y la educación ha creado un paisaje dinámico que presenta tanto oportunidades como desafíos. Los estudiantes de hoy tienen a su disposición una vastedad de información sin precedentes, herramientas de aprendizaje interactivas y plataformas para la autoexpresión. Sin embargo, la profusión de contenido y la naturaleza siempre conectada de estos medios pueden influir en su salud mental y su percepción de identidad, lo que plantea la necesidad de una educación mediática efectiva.

El análisis revela que, mientras la mayoría de los estudiantes utiliza activamente los medios digitales para obtener información y para expresar su identidad, hay una brecha discernible en la capacidad de discernir la veracidad del contenido y gestionar la presión de presentar una autoimagen ideal. Estas realidades subrayan la importancia de una educación mediática robusta que no solo enseñe a los estudiantes a navegar por el contenido, sino también a entender y gestionar las emociones y percepciones asociadas con su consumo y producción.

En el horizonte educativo, es imperativo que las instituciones escolares, los educadores y los stakeholders reconozcan y aborden estos desafíos. Implementar programas educativos que fomenten una relación saludable con los medios digitales, promoviendo simultáneamente habilidades críticas de pensamiento y autoconciencia, será esencial para preparar a los estudiantes para la era digital, garantizando su bienestar y fortaleciendo su capacidad de participar de manera informada y empoderada en la sociedad digital.

Los hallazgos de esta investigación reflejan que, aunque los medios digitales se han convertido en una parte integral de la vida cotidiana de los estudiantes, existen vacíos significativos en su capacidad para utilizar estos medios de manera crítica y segura. La escasa alfabetización mediática y la tendencia a aceptar la información en línea sin un análisis crítico pueden exponer a los estudiantes a información errónea y a influencias dañinas.

Además, los medios digitales parecen tener un impacto considerable en la salud mental de los estudiantes. La prevalencia de sentimientos de estrés y ansiedad asociados con el uso de los medios digitales sugiere la necesidad de proporcionar a los estudiantes herramientas y estrategias para manejar la sobrecarga de información y las presiones de la presentación en línea.

A la luz de estos hallazgos, se recomienda que las instituciones educativas implementen una educación mediática sólida en sus currículos. Esto debe incluir la enseñanza de habilidades de pensamiento crítico para el análisis de medios, así como estrategias para manejar la sobrecarga de información y la salud mental en línea. También se debe proporcionar apoyo a los estudiantes en su navegación por los espacios digitales en lo que respecta a la formación de la identidad y la autoimagen.

Este estudio destaca la urgencia de integrar la educación mediática en las escuelas para equipar a los jóvenes con las habilidades necesarias para interactuar de manera segura y efectiva con los medios digitales en la era moderna, a través de un proceso que los autores denominan cibereducación (Rojas-Bahamón, et al, 2023). De esta manera, es crucial que las políticas y las prácticas educativas se adapten para reflejar la creciente influencia de los medios digitales en la vida de los estudiantes.

Referencias bibliográficas

Arbeláez-Campillo, D. F., Tatsiy, V. Y., Rojas-Bahamón, M. J., & Danilyan, O. G. (2020). Contributions of critical thinking as a form of participation and political deliberation. *Amazonia Investiga*, *9*(27), 5–12. https://doi.org/10.34069/AI/2020.27.03.1

Best, P., Manktelow, R., & Taylor, B. (2014). Online communication, social media and adolescent wellbeing: A systematic narrative review. *Children and Youth Services Review, 41*, 27-36. https://doi.org/10.1016/j.childyouth.2014.03.001

Buckingham, D. (2007). Digital Media Literacies: Rethinking Media Education in the Age of the Internet. *Research in Comparative and International Education, 2*(1), 43-55. https://doi.org/10.2304/rcie.2007.2.1.43

Couldry, N., & Hepp, A. (2017). *'The Mediated Construction of Reality'*. Polity Press. https://onx.la/d73ea

Fardouly, J., Diedrichs, P. C., Vartanian, L. R., & Halliwell, E. (2015). Social comparisons on social media: the impact of Facebook on young women's body image concerns and mood. *Body image, 13*, 38-45. https://doi.org/10.1016/j.bodyim.2014.12.002

Hobbs, R. (2010). *'Digital and Media Literacy: A Plan of Action'.* The Aspen Institute, pp. 1-63. https://onx.la/41506

Jenkins, H. (2009). *Confronting the challenges of participatory culture: Media education for the 21st century*. Cambridge, MA: MIT Press.

Kowalski, R. M., Giumetti, G. W., Schroeder, A. N., & Lattanner, M. R. (2014). Bullying in the digital age: A critical review and meta-analysis of cyberbullying research among youth. *Psychological bulletin, 140*(4), 1073. https://doi.org/10.1037/a0035618

Lewandowsky, S., Ecker, U. K., & Cook, J. (2017). Beyond Misinformation: Understanding and Coping with the "Post-Truth" Era. *Journal of Applied Research in Memory and Cognition, 6*(4), 353-369. https://doi.org/10.1016/j.jarmac.2017.07.008

Lister, M., Dovey, J., Giddings, S., Grant, I., & Kelly, K. (2008). *New media: A critical introduction*. Routledge. https://doi.org/10.4324/9780203884829

Manago, A.M., Graham, M.B., Greenfield, P.M. & Salimkhan, G. (2008). 'Self-presentation and gender on MySpace'. *Journal of Applied Developmental Psychology, 29*(6), 446-458. https://doi.org/10.1016/j.appdev.2008.07.001

Misra, S., & Stokols, D. (2012). Psychological and Health Outcomes of Perceived Information Overload. Environment and Behavior, 44(6), 737-759. https://doi.org/10.1177/0013916511404408

OMS (2018). *Mental health: Strengthening our response*. World Health Organization. Available: https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response.

Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior, 29*(4), 1841-1848. https://doi.org/10.1016/j.chb.2013.02.014

Rojas-Bahamón, M. J., Pulido Jiménez, A., & Serrato Rodríguez, Y. (2023). Prácticas de seguridad de la información en estudiantes de escuela secundaria en Colombia. *Entre Ciencia E Ingeniería, 17*(33), 16-23. https://doi.org/10.31908/19098367.2832

Rojas Bahamón, M. (2012). Diagnóstico acerca del uso y apropiación de las TIC como mediación didáctica. *Amazonia Investiga*, *1*(1), 5-18. https://doi.org/10.34069/AI/2012.01.02.1

Turkle, S. (1995). *Life on the screen: Identity in the age of the Internet*. New York: Simon & Schuster. https://onx.la/62167

Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2017). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among U.S. adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science, 6*(1), 3–17. https://doi.org/10.1177/2167702617723376

Twenge, J.M., & Campbell, W.K. (2018) 'Media use is linked to lower psychological well-being: Evidence from three datasets'. *Psychiatric Quarterly, 89*(2), 311-331. https://doi.org/10.1007/s11126-019-09630-7

Vannucci, A., & McCauley Ohannessian, C. (2019). Social media use subgroups differentially predict psychosocial well-being during early adolescence. Journal of Youth and Adolescence, 48(8), 1469-1493. https://link.springer.com/article/10.1007/s10964-019-01060-9

Vosoughi, S., Roy, D., & Aral, S. (2018) 'The spread of true and false news online'. *Science, 359*(6380), 1146-1151. https://doi.org/10.1126/science.aap9559

Wardle, C., & Derakhshan, H. (2017). *'Information Disorder: Toward an interdisciplinary framework for research and policymaking'*. Council of Europe Report, pp. 1-110. https://onx.la/4eef1

Zhao, S., Grasmuck, S., & Martin, J. (2008). Identity construction on Facebook: Digital empowerment in anchored relationships. *Computers in human behavior, 24*(5), 1816-1836. https://doi.org/10.1016/j.chb.2008.02.012

ONLINE ISSN: 2665-0223
PRINT ISSN: 1856-7576