Digital technologies and professional training: The case of human interaction specialists

Tecnologías digitales y formación profesional: el caso de los especialistas en interacción humana

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Abstract

This study aims to substantiate and experimentally verify the effectiveness of integrating digital technologies and artificial intelligence (AI) into the professional training of future Human-Interaction Specialists in higher education. A quasi-experimental mixed-methods design with a pretest–posttest control group structure was conducted during 2022–2025. Participants were undergraduate and graduate students of socio-humanitarian and pedagogical specialties. Professional readiness was defined as a multidimensional construct including motivational, procedural, creative, and reflective-evaluative components. Data were collected through questionnaires, competence-based testing, creative tasks, observation, and reflective assessment. Pearson's chi-square test (χ^2; $p < .05$) was applied to determine statistical significance. At the baseline stage, most students demonstrated low readiness levels (motivational – 56%; procedural – 62%; creative – 38%). After implementing the digital pedagogical model in the Experimental Group, the proportion of students with high levels increased significantly: motivational (4%→29%), procedural (20%→47%), creative (10%→29%), and reflective-evaluative (28%→44%). Posttest χ^2 values exceeded the critical threshold (5.991), confirming statistically significant differences between groups. The findings demonstrate that a structured digital educational environment integrating AI-based tools significantly enhances professional readiness. The study empirically validates a multi-component model of readiness formation and supports the pedagogical effectiveness of AI integration in higher education.

Keywords: professional training of specialists, digital technologies, diagnostics, digitalization of the educational environment, artificial intelligence.

Resumen

Este estudio tiene como objetivo fundamentar y verificar experimentalmente la efectividad de la integración de tecnologías digitales e inteligencia artificial (IA) en la formación profesional de futuros especialistas en interacción humana en la educación superior. Se llevó a cabo un diseño cuasi experimental de métodos mixtos con una estructura de grupo de control pretest-postest durante 2022-2025. Los participantes fueron estudiantes de pregrado y posgrado de especialidades sociohumanitarias y pedagógicas. La preparación profesional se definió como un constructo multidimensional que incluye componentes motivacionales, procedimentales, creativos y reflexivos-evaluativos. Los datos se recopilaron mediante cuestionarios, pruebas basadas en competencias, tareas creativas, observación y evaluación reflexiva. Se aplicó la prueba de chi-cuadrado de Pearson (χ^2; $p < .05$) para determinar la significancia estadística. En la etapa inicial, la mayoría de los estudiantes demostraron bajos niveles de preparación (motivacional - 56%; procedimental - 62%; creativo - 38%). Tras la implementación del modelo pedagógico digital en el Grupo Experimental, la proporción de estudiantes con niveles altos aumentó

significativamente: motivacional (4%→29%), procedimental (20%→47%), creativo (10%→29%) y reflexivo-evaluativo (28%→44%). Los valores de χ² del postest superaron el umbral crítico (5,991), lo que confirma diferencias estadísticamente significativas entre los grupos. Los hallazgos demuestran que un entorno educativo digital estructurado que integra herramientas basadas en IA mejora significativamente la preparación profesional. El estudio valida empíricamente un modelo multicomponente de formación de la preparación y respalda la eficacia pedagógica de la integración de IA en la educación superior.

Palabras clave: formación profesional de especialistas, tecnologías digitales, diagnóstico, digitalización del entorno educativo, inteligencia artificial.

Introduction

Modern progress in science, industry, and technology requires professionals to have a deeper understanding of their field and to acquire competencies such as teamwork, communication, and creativity. Therefore, the question of how future specialists are professionally trained in higher education, and how teachers prepare students for the challenges of the modern labor market and for societal competitiveness, becomes an important, relevant, and cutting-edge topic for discussion. The formation of professional competence in future Human-Interaction Specialists and the development of socially significant qualities in conditions that are close to production are the result of the integration of production and education, these two types of activity, each of which contributes to the solution of various tasks and the achievement of different goals (Farias-Gaytan et al., 2023).

The implementation of digital technologies in higher education has become a defining trend in contemporary pedagogy. Education continually requires the integration of technological solutions into the socio-cultural space, necessitating the adaptation of the educational process to dynamic changes in digital infrastructure. The rapid development of information technologies stimulates this need. New opportunities for effective learning and the development of students' creativity and critical thinking emerge through digital technologies, affect students' cognitive processes and teaching methods and pedagogical strategies, and are necessary to ensure their professional and social adaptation in a modern digital society (Gutiérrez et al., 2019).

In higher education, the integration of digital technologies into the training of future Human-Interaction Specialists is also linked to the regulatory and legislative requirements governing this process in society. Therefore, there is a need for a deep understanding of the specific use of digital technologies in pedagogical contexts.

In this study, the term Human-Interaction Specialists is used as an operational category referring to future professionals in socio-humanitarian fields whose core professional activity is based on direct interpersonal interaction, communication, counseling, education, and social support within institutional and community contexts. This category includes, in particular, future teachers, social workers, psychologists, special and inclusive education specialists, and other professionals whose work requires the development of communicative competence, emotional intelligence, reflective thinking, and the ability to operate effectively in digitally mediated environments.

Within the framework of this research, Human-Interaction Specialists are defined as higher education students preparing for professions in which interpersonal communication, ethical responsibility, and adaptive decision-making constitute the

primary functional components of professional activity, especially under conditions of digital transformation.

Therefore, innovation and improvement of the pedagogical aspects of the use of digital technologies in the professional training of future specialists in higher education are critically important for developing effective modern methods of the educational process that meet the requirements of digitalized education.

Literature Review

The significance of the theory of the informatization of education, and of psychological and pedagogical research in the context of modern digitalization, is evident in the analysis of the impact of digital technologies on learning processes in higher education.

Hamdan-Mansour et al. (2026) examined the relationship between the use of artificial intelligence (AI) and health specialty students' critical thinking, clinical competence, and willingness to practice human interaction skills at Jordanian universities. Surveying 542 students with validated instruments, the study found that students generally held positive attitudes toward AI, reporting that it supported their critical thinking, general skills, and clinical competency. AI use showed significant positive correlations with critical thinking (r = 0.42), clinical competency, and communication skills (r = 0.15), although the explained variance was modest (R² ranging from 2.4% to 17.3%). The findings highlight the potential of integrating AI into health education to enhance students' analytical, clinical, and communication capabilities, supporting its inclusion in curricula and pedagogical strategies.

Hamdan-Mansour et al. (2026) discuss the implications of perceiving artificial intelligence (AI) as conscious in human-AI interactions. The authors argue that whether AI is inherently conscious is less relevant than the fact that users often treat AI as if it were conscious, which can influence subsequent human-human interactions. This "carry-over effect" occurs because interacting with humanlike AI – such as chatbots, digital assistants, or social robots – activates mental schemas similar to those used in human interactions, shaping behavior and perceptions toward other people. The paper reviews evidence from human-computer and human-AI interaction studies and explains how schema activation can be measured as a driver of these effects. Ultimately, the study suggests that the design and regulation of AI should account for its perceived consciousness to manage behavioral outcomes. At the same time, moral considerations for AI may also be relevant, irrespective of its actual sentience.

Beyan et al. (2023) provide a comprehensive survey on automated analysis of co-located human–human interactions using nonverbal cues. Covering studies since 2010, the review examines how social traits (e.g., leadership, dominance, personality), social roles, and interaction dynamics (e.g., engagement, rapport, group cohesion) are detected through computational methods. The authors highlight commonly used cues and techniques, such as speaking activity, support vector machines, and meeting scenarios with microphones and cameras, while noting that multimodal features and deep learning architectures generally improve performance. The survey also identifies gaps, including the lack of scalable benchmarks, inconsistent annotation reliability, few cross-dataset experiments, and insufficient explainability. Additionally, the paper summarizes relevant datasets and outlines future directions, emphasizing AI implementation, dataset curation, and privacy-preserving interaction analysis.

Shen & Wang (2023) investigated how social skills influence lexical alignment – the tendency to match a conversational partner's word choices – in human-human (HHI) versus human-computer interaction (HCI). Using a speech-based picture naming and matching task with social skills measured by the Chinese University-students Social Skill Inventory (ChUSSI), the study found that lexical alignment was stronger in HCI (79.5%) than in HHI (58.6%). Notably, participants' concern for their partner's social standing (Partner's Mianzi) significantly predicted alignment in HHI but not in HCI, indicating that social considerations influence language behavior only when interacting with humans. These results highlight a boundary in how individuals cognitively represent human versus computer interlocutors, suggesting that social cues play a limited role in HCI.

The rapid integration of digital technologies and artificial intelligence (AI) into higher education has stimulated extensive interdisciplinary research. However, the pedagogical mechanisms explaining *how* learning occurs within AI-mediated environments require clearer theoretical grounding. To address this gap, the present study integrates digital transformation research with contemporary learning theories, particularly self-regulated learning, connectivism, and competence-based education.

The theory of **self-regulated learning (SRL)** explains how learners actively plan, monitor, and evaluate their cognitive and motivational processes. Digital tools and AI-based adaptive systems enhance SRL by providing immediate feedback, personalized learning trajectories, and progress tracking mechanisms. Intelligent tutoring systems, automated assessment, and chatbots support metacognitive reflection and formative feedback, thereby strengthening reflective-evaluative components of professional readiness. Empirical research demonstrates that AI-supported environments foster critical thinking and self-monitoring skills when aligned with pedagogical objectives rather than purely technical functionalities.

The concept of **connectivism**, proposed in the context of networked digital environments, emphasizes learning as the ability to construct and navigate knowledge networks. From this perspective, digital platforms, social networks, and AI-driven recommendation systems function as nodes within an expanded cognitive ecosystem. Learning occurs through interaction, collaboration, and access to distributed knowledge sources. Thus, the use of learning management systems, collaborative tools, and AI chatbots aligns with connectivist principles by enabling dynamic knowledge exchange and continuous professional development.

Within the **competence-based approach**, professional training is viewed as the formation of integrated cognitive, practical, motivational, and reflective components. Digital technologies facilitate competence formation by simulating professional contexts, modeling real-life scenarios, and supporting adaptive problem-solving. AI-driven simulations and virtual environments create conditions for experiential learning, which is particularly relevant for Human-Interaction Specialists whose professional effectiveness depends on communication, adaptability, and ethical decision-making.

Previous empirical studies highlight the growing impact of AI in education. Research demonstrates positive correlations between AI use and the development of critical thinking and communication skills (Hamdan-Mansour et al., 2026). Systematic reviews of AI in higher education emphasize personalization, automated feedback, and adaptive learning as key pedagogical affordances (Ouyang et al., 2022). Studies on chatbot interaction further reveal that perceived social presence influences

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engagement and learning outcomes (Chaves & Gerosa, 2021). However, highly technical analyses of human–computer interaction (e.g., lexical alignment or nonverbal cue detection) often lack pedagogical contextualization, which limits their applicability to professional training models.

Therefore, integrating AI tools into professional education requires alignment with established learning theories. AI should not be conceptualized solely as a technological innovation but as a pedagogical instrument that supports self-regulation, networked learning, reflective practice, and competence development. This theoretical integration provides the conceptual justification for selecting digital tools in the present study and explains the mechanisms through which they influence the formation of professional readiness in future Human-Interaction Specialists.

Purpose of the article. Improving the professional training of future Human-Interaction Specialists using digital technologies in higher education.

Methodology

Research Design

This study employed a quasi-experimental mixed-methods design with a pretest–posttest control group structure. The research aimed to determine the effectiveness of pedagogical conditions and digital technologies (including artificial intelligence tools) in enhancing the professional readiness of future Human-Interaction Specialists.

The design included both quantitative (diagnostic measurements, statistical testing) and qualitative components (observation, reflective analysis). The intervention model was implemented over three academic years (2022–2025).

Participants (Sample)

The study involved N = 128 students enrolled in socio-humanitarian and pedagogical specialties at three Ukrainian higher education institutions. The participants were undergraduate (3rd–4th year) and graduate (1st year Master's) students preparing for professions classified in this study as Human-Interaction Specialists (teachers, social workers, psychologists, and specialists in inclusive education).

Participants were divided into two groups:

− Experimental Group (EG): n = 64
− Control Group (CG): n = 64

Group assignment was based on intact academic groups to preserve the natural educational setting. Baseline equivalence between the EG and CG was verified using Pearson's chi-square test (χ^2emp < χ^2crit = 5.991; p > .05), confirming no statistically significant differences in readiness levels prior to the intervention.

The gender distribution reflected the typical demographic profile of socio-humanitarian specialties (approximately 78% female, 22% male). The average age of participants was 20.8 years (SD = 1.4).

Inclusion criteria:

− Enrollment in a socio-humanitarian or pedagogical program.

−   Participation in digital learning courses during the study period.
−   Voluntary informed consent.

Exclusion criteria:

−   Incomplete participation in diagnostic procedures.
−   Absence during either pretest or posttest measurements.

Participation was voluntary, and all respondents provided informed consent. Data were anonymized in accordance with ethical standards for educational research.

Conceptual Framework and Variables

The study was grounded in digital transformation theory in higher education and competence-based professional training models.

Independent Variable: Implementation of pedagogical conditions integrating digital technologies and AI tools.

Dependent Variable: Level of professional readiness for activity in a digital educational environment.

Professional readiness was operationalized as a multidimensional construct comprising four components: motivational, procedural, creative, reflective-evaluative.

Each component was measured at three levels: high, average, and low.

Instruments and Measures

A set of validated diagnostic tools was developed based on theoretical analysis and expert evaluation.

Quantitative Instruments:

−   Structured questionnaires (motivation, digital readiness)
−   Diagnostic testing (procedural competence)
−   Creative problem-solving tasks
−   Reflective-evaluative ranking scales

Qualitative Instruments:

−   Systematic observation
−   Structured interviews
−   Reflective written self-assessments
−   Portfolio analysis

Content validity was ensured through expert review. Construct validity was supported by alignment between theoretical definitions and operational indicators.

Procedure

The research was conducted in four stages:

Stage 1 – Theoretical and Analytical Phase

A systematic literature review was conducted to establish theoretical foundations.

Stage 2 – Ascertaining Phase (Pretest)

Baseline diagnostics were performed to determine initial readiness levels across all four components.

Stage 3 – Formative Intervention Phase

The Experimental Group was exposed to a structured pedagogical model including:

- Learning Management Systems (Moodle, Google Classroom)
- Interactive digital simulations and role-play modeling
- AI-based adaptive learning systems and chatbots
- Personalized digital assessment tolos
- Electronic portfolios
- Gamified learning elements

The Control Group continued traditional instruction.

Stage 4 – Control (Posttest) Phase

Post-intervention diagnostics were administered using identical measurement instruments.

Data Analysis

Quantitative data were analyzed using inferential statistics.

Pearson's chi-square (χ^2) test for independence was applied to compare distributions across readiness levels.

Significance level was set at $p < .05$.
Degrees of freedom (df = 2).
Critical value: $\chi^2_{crit} = 5.991$.
At the ascertaining stage:
$\chi^2_{emp} < \chi^2_{crit}$, indicating no significant differences between groups.

At the posttest stage: $\chi^2_{emp} > \chi^2_{crit}$ across all readiness components, demonstrating statistically significant improvements in the Experimental Group.

Descriptive statistics (percentage distributions) were also used to assess dynamic changes.

Reliability and Validity

Internal consistency was ensured through standardized administration procedures.

Content validity was confirmed by expert panel review. Statistical validity was supported by inferential analysis. Construct reliability was ensured by multi-component operationalization.

Ethical Considerations

The study adhered to ethical standards for educational research:

– Voluntary participation
– Informed consent
– Confidentiality and anonymity
– Transparent data processing
– No personal identifiers were collected.

Results and Discussion

The content and importance of the use of digital technologies in higher education; innovative approaches to the formation of the structure and content of training; and the identification of a system of principles and methodological requirements that underpin the training of Human-Interaction Specialists.

New organizational forms of work, flexible automated production processes, and the widespread use of digital technologies have significantly altered the professional training of a modern specialist. The modern labor market is changing the requirements for the professional qualifications of Human-Interaction Specialists, requiring greater versatility in their professional functions and the use of digital technologies in their activities. This is because digital technologies, whose importance is constantly growing, serve as the intellectual core and functional components of other technologies. The use of digital technologies significantly increases the efficiency of other technologies while simultaneously reducing costs and resource use across society. In training Human-Interaction Specialists, digital technologies in higher education serve to achieve educational goals. The need to improve the quality of training future Human-Interaction Specialists, in particular, the formation of professional competence in students, requires the introduction of more effective methods of organizing the educational process and training in the educational sector. The creation of an educational environment in a new digital format is essential to training competitive specialists for the labor market, who require modern professional competencies and continually develop professionally significant qualities throughout their lives (Xia et al., 2025).

It is the mastery of digital technologies that makes specialists' professional activities more productive and effective, as it enables the use of digital, innovative, and interactive methods of teaching and learning. In the modern educational environment, information support should be at a sufficiently high level to enable a Human-Interaction Specialist to address all educational and training tasks effectively and efficiently.

This study substantiates the need for integrating digital technologies into higher education and outlines key principles guiding the training of Human-Interaction Specialists.

– The principle of integrated systematicity ensures the comprehensive development of professional competence through interconnected digital platforms, interdisciplinary tasks, and coordinated educational elements.
– The principle of professional orientation aligns training with labor market demands by incorporating simulations, virtual environments, case-based

learning, and collaboration with employers to provide practice-oriented experience.

− The principle of integrativity promotes a holistic educational system that combines theoretical and practical components through digital simulations, interactive tools, and assessment systems.

− The principle of interactivity establishes students as active participants in learning through discussions, group projects, gamification, and problem-based activities that foster creativity and critical thinking.

− The principle of individualization supports personalized learning paths via adaptive platforms, digital consultations, and progress-tracking assessment systems.

− The principle of social responsibility ensures ethical use of digital tools, data protection, inclusivity, and equal access to educational resources.

− Finally, the principle of reflection emphasizes systematic self-assessment supported by e-portfolios and digital feedback tools, promoting metacognitive awareness and continuous professional development (Chaves & Gerosa, 2021).

Classification of digital tools that allow teachers to create conditions for high-quality professional training and diagnostics of future Human-Interaction Specialists in the educational electronic environment of higher education. Application of artificial intelligence to improve the quality of higher education.

Let us consider digital tools that are necessary for the educational activity of future Human-Interaction Specialists in the educational environment, which are classified in several areas:

− Social networks, such as Instagram, LinkedIn, Facebook, Clubhouse, Twitter, Ning, Academia.edu, play an important role in the exchange of experience between scientists and students and the establishment of professional contacts.

− Learning Management Systems, such as Google Classroom, Canvas, Moodle, Blackboard, and WebCT, contribute to the implementation of educational processes and support the implementation of online courses at various levels.

− Interpersonal communication tools: Viber, ZOOM, Telegram, Skype, Discord, WhatsApp, which provide modern communication between participants in the educational process.

− Tools for interaction, publication, sharing, including video lectures, YouTube, e-books, podcasts, Wikis, Google documents, Blogs, Mind Maps, social bookmarks, which facilitate knowledge sharing and collaboration.

− Mobile applications, software for mobile devices (tablets and smartphones), which facilitate learning anywhere and at any time.

− Virtual reality programs and online games, as well as virtual laboratories for real-time work, allow controlled experiments and the reproduction of real-world conditions.

− Content aggregation tools, such as Google Reader, NetVibes, and RSS feeds, help organize and quickly collect text data.

− Feedback and assessment systems, such as electronic testing through Moodle, Google Forms; electronic note-taking and reflection systems, such as Trello, Pages, Evernote (Tzirides et al., 2024).

Such a classification in the modern digital world underscores the importance of digital technologies in preparing students for active professional practice and the development of professional competence. These digital tools have the potential to increase the flexibility of learning and its effectiveness for future Human-Interaction Specialists, allowing teachers to adapt educational materials to students' individual

needs and to support their active participation in the educational process. Such individualization and adaptation of learning contribute to the deep assimilation of professional material but, at the same time, pose new challenges to the educational system and require the provision of appropriate technical support and high-quality, modern teacher training for the effective use of digital technologies. The integration of digital technologies into higher education introduces innovations into educational processes and methods. The use of these technologies radically modifies the educational context, expanding educational opportunities by increasing the availability of materials and interactive tools and by individualizing the educational process (Ciampi et al., 2025).

A property of intelligent systems is artificial intelligence, which enables students to perform creative functions characteristic of the individual by acquiring knowledge, interpreting external data appropriately, and adapting to innovations to achieve specific goals (Mytnyk et al., 2024).

In the modern world, the use of artificial intelligence in the professional training of Human-Interaction Specialists is highly relevant. The following key capabilities of modern technology emphasize the importance of artificial intelligence:

− Ensuring the accessibility of artificial intelligence is a valuable tool for those who lack physical access to training and for providing education to those with limited opportunities.
− Adaptation to learning, different teaching styles – can adapt to the skills of applicants, different learning styles, supporting them;
− Personalized learning contributes to improved outcomes and enables the creation of individualized educational programs that enhance learning effectiveness, taking into account each applicant's educational level and needs.
− Digital skills training – the use of artificial intelligence in education helps applicants in the educational space to assess their capabilities and limitations, learn to use technology, and modern innovations.
− Teacher support – artificial intelligence can help teachers manage their classrooms, automate administrative tasks, and provide analytical data for research.
− Innovation and research: artificial intelligence is an area of active research that stimulates innovation in education and promotes the development and implementation of new technologies.
− Forecasting and analysis: artificial intelligence helps analyze educational data volumes, improve educational programs, enable universities to predict trends, and identify problems in education (Bonami et al., 2020).

Artificial intelligence is widely used in higher education, including personalized learning, automated assessment of academic achievement, adaptive learning, interval learning with the ability to provide personalized assistance, response analysis, and evaluation, among other applications.

Voice assistants and chatbots play a major role in this, as they enable productive and personalized online learning and simplify it (Ouyang et al., 2022).

In higher education, the use of a chatbot is important for creating a favorable environment for studying professional disciplines, due to its high potential in the field of education, as the convenience of using a chatbot has been proven, since access to it is available at any time. Students felt more confident working with a bot than working with a live teacher (Haristiani, 2019).

The most popular chatbot today is ChatGPT. In personalized, adaptive learning, scientists focus on the advantages of its use (Rudolph et al., 2023). Using ChatGPT provides high-quality feedback, enhances study at the higher education level, offers its own advice, and can serve as a partner in conversations about improving professional mastery (Bin-Hady et al., 2023).

Artificial intelligence technologies are currently actively used in higher education. Let us note the main directions in the educational process of training specialists using artificial intelligence:

- Some electronic learning assistants create personalized tasks and interactive training sessions by using artificial intelligence.
- Systems for tracking the progress of future Human-Interaction Specialists help identify the strengths and weaknesses of the system and analyze the automated assessment of tasks, ensuring an objective and rapid assessment of students' knowledge levels (Chu et al., 2022).
- Support for individuals with special educational needs – the ability to support students with special educational needs by providing tools and adaptive learning materials.
- Virtual simulations and labs – using artificial intelligence, universities are creating virtual environments for simulations and experiments, allowing students to learn in more accessible and safe conditions.
- Large-scale education and online courses – platforms such as edX, Coursera, and Udacity are using artificial intelligence to deliver online courses worldwide and to expand access to higher education for students (Farrokhnia et al., 2024).

Organization of the study

The study was conducted from 2022 to 2025 and covered the following stages.

At the first theoretical stage, a review of the literature on research issues was conducted to determine the study's theoretical foundations and experimental basis.

At the second, exploratory stage, the goal was determined; a theoretical justification of scientific provisions was carried out; an ascertaining study was carried out, a methodology and program of the experiment were developed – the formative stage. In the third experimental stage, the effectiveness of the pedagogical conditions for training future Human-Interaction Specialists was tested.

At the fourth, generalizing stage, the study's results were systematized, general conclusions were formulated, and research prospects were determined.

The development of readiness among future Human-Interaction Specialists for professional practice was characterized as a dynamic, complex process of continual change in a digitalized society. The following criteria were included in the assessment of the quality of such training:

- Motivational criterion.
- Practical criterion.
- Creative criterion.
- Evaluation criterion.

The content characteristics of the criteria and their indicators for assessing readiness for professional activity among future Human-Interaction Specialists were

developed, reflecting the component structure of the studied object and the levels of personal development (high, average, low).

The components of readiness are prescribed as motivational, procedural, creative, and reflective-evaluative.

The results of long-term observations, theoretical research, and experiments made it possible to develop pedagogical conditions for professional training in a digitalized society for future Human-Interaction Specialists, such as: creating an emotional and positive environment using digital technologies; the development of the innovative potential of Human-Interaction Specialists and the creative richness of the content of the digital environment of higher education; methodological literacy of students in organizing the digital environment of higher education and in implementing the system of professional training of specialists; scientific and methodological digital support for Human-Interaction Specialists, which determines the effectiveness of their professional training.

Analysis of the state of readiness of future Human-Interaction Specialists for professional non-standard activities in the digital environment of society.

The methodological and theoretical foundations of professional training for the selected professional activity, Human-Interaction Specialists, developed during the research necessitated experimental work.

The purpose of the experimental work at the ascertaining stage was to present the results of diagnosing the level of readiness of future specialists for non-standard professional activity in the digital environment.

The results of the diagnostics of students' creative digital abilities at the beginning of the experimental study showed the following levels of students' creative abilities: The reproductive level of students' creative abilities was − 38%.

The practical level of students' creative abilities was − 52%.
The level of students' creative abilities was −10%.

The results of the questionnaire at the ascertaining stage showed that most students are prone to stereotyping when performing educational tasks, subjective views dominate in the organization of educational activities, in the assessment of their actions, we observe a lack of technological tools, and the implementation of digital technologies into the content of education is at a low level.

Analysis of the professional training of future Human-Interaction Specialists indicates a gap between the actual development of students' digital competence and their perceptions of productive professional activity in society's digital environment.

Table 1.
Levels of formation of components of readiness of future specialists for non-standard activity in the digital environment at the ascertaining stage of the pedagogical experiment (%)

Readiness components	Low Level	Average Level	High Level
	%	%	%
Motivational	56%	40%	4%
Procedural	62%	18%	20%
Creative	37%	53%	10%
Reflective-evaluative	39%	32%	29%

At the stage of experiment design, based on the diagnostic results, we formed an experimental group and a control group.

The experimental group included the following groups of students, in which relatively lower results were observed in the control sections.

In the control group (CG), student professional training was conducted according to the traditional method. In contrast, in the experimental group (EG), training was conducted according to the developed pedagogical conditions and an innovative method.

The hypothesis of the presence of statistically significant differences between the level of training of students of the experimental and control groups at the stage of the ascertaining experiment was tested using the χ^2 – Pearson criterion.

As the null hypothesis H_0, the statement was chosen: "The level of training of respondents of the experimental and control groups at the stage of the ascertaining experiment has statistically significant differences".

As the alternative hypothesis H_1, the statement was accepted: "There are no statistically significant differences in the level of training of respondents of the experimental group and the control group at the stage of the ascertaining experiment".

During the ascertaining stage of the experiment, diagnostic studies were conducted on the level of formation of each of the structural components of the readiness of future Human-Interaction Specialists for professional activity in the digital society, which allowed us to say that the vast majority of respondents have an insufficient level of formation of the studied personal formation.

Therefore, the developed pedagogical conditions for professional training in a digitally transformed society for future Human-Interaction Specialists were implemented in the EG.

The key aspects of the use of digital technologies in higher education in the EG were the ability to expand and enrich traditional forms of the educational process, including interactivity, digital tools, multimedia materials (virtual laboratories and simulations), and open educational resources and online courses.

The use of open educational resources enabled us to offer EG respondents a flexible and accessible educational system, which was significant for the digitalization of higher education and the context of globalization. This allowed students to choose from a wide range of educational components, regardless of their financial capabilities or location. Digitalization of education has brought innovations to the training of future EG specialists through the personalization of the educational process.

The use of artificial intelligence in EG had a significant impact on the development of higher education by adapting the educational process to the individual needs of future Human-Interaction Specialists, thereby significantly increasing the quality of higher education. The use of artificial intelligence in higher education had an important practical significance and scientific basis, as it contributed to ensuring interactivity, adaptability, and personalization of the educational process, allowed the teacher to choose the optimal format of training, develop a high-quality course and promptly correct it, offer students innovative ways to assess the level of

assimilation of educational material, etc. The use of artificial intelligence in higher education has created significant opportunities for addressing this issue.

After completion of the formative stage of the experiment, analysis of the results across all components indicated positive trends.

Let us show it step by step.

The motivational component of readiness for professional non-standard activities in the digital environment among EG students, compared with CG students, was examined first. We assumed that if at the stage of the ascertaining cut the value of the statistical criterion $\chi^2_{emp} < \chi^2_{crit}$ for the motivational component was obtained (2.171 < 5.991), then this indicates the absence of differences in the formation of this component, which is a significant sign of interest in EG and CG students, then after the completion of the formative stage of the experiment, statistically significant differences in the results (8.582 > 5.991) are transferred to the category of statistically significant differences in the results (8.582 > 5.991), since at this stage $\chi^2_{emp} > \chi^2_{crit}$.

Table 2.
Dynamics of the levels of formation of the motivational component of students' readiness for activities in the digital environment at the formative stage of the pedagogical experiment (%)

Level of formation	Motivational component			
	Ascertaining stage		Formative stage	
	CG	EG	CG	EG
High Level	4%	4%	8%	29%
Average Level	40%	39%	48%	54%
Low Level	56%	57%	44%	17%

At the control stage of the study, to determine the extent of the formation of the procedural component of readiness for non-standard professional activity in the digital environment, students were presented with various tasks designed to assess their knowledge of a professional field in the modern digital society. At the level of tasks, respondents were offered reproductive-type tasks – they were offered to evaluate their own professional actions that take place in the digital environment of professional activity. While performing productive tasks, the EG respondents demonstrated their vision for solving professional problems. We observe in the EG the manifestation of non-standard thinking among respondents in solving problems in education and the workplace.

The results obtained are reflected in Table 3.

Table 3.
Dynamics of the levels of formation of the procedural component of students' readiness for activity in the digital environment at the formative stage of the pedagogical experiment (%)

Level of formation	Procedural component			
	Ascertaining stage		Formative stage	
	CG	EG	CG	EG
High Level	19%	20%	23%	47%
Average Level	18%	18%	29%	36%
Low Level	63%	62%	48%	17%

The results presented in the table indicate that respondents in both groups (CG and EG) exhibited low levels of formation at the stage of ascertaining the procedural component of readiness. χ^2_{emp}=1.443 − according to the calculated statistical empirical criterion, this value is less than the critical χ^2_{crit}=5.991. At the initial stage of the experiment, respondents in the EG and CG groups did not differ significantly in the degree of formation of the procedural component of readiness.

We observed positive dynamics following completion of the formative experiment in EG students, indicating the development of creative abilities.

AFTER the completion of the experimental program, the value of the Pearson statistical criterion indicates the presence of significant statistical differences between the results of EG and CG students in the levels of formation of the procedural component (versus χ^2_{crit}=5.991 − criterion χ^2_{emp}=7.577).

To assess the extent of the creative component of readiness, respondents were given test papers containing tasks at the reproductive, productive, and creative levels.

Reproductive-type tasks: students at this level were required to evaluate their own professional actions and those of colleagues in traditional practice within the specialty.

Productive type tasks: students expressed their own thoughts on solving a professional problem.

Creative-type tasks involved non-standard problem-solving and creative actions. The results of the experiment are shown in Table 4.

Table 4.
Dynamics of levels of formation of the creative component of students' readiness for activity in a digital environment at the formative stage of the pedagogical experiment (%)

Level of formation	Creative component			
	Ascertaining stage		Formative stage	
	CG	EG	CG	EG
High Level	9%	10%	15%	29%
Average Level	53%	52%	59%	63%
Low Level	38%	38%	26%	8%

Table 4 shows that, at the ascertaining stage of the experiment, respondents in the CG and EG groups exhibited a low level of formation of the creative component of readiness.

χ^2_{emp}=1.4454 according to the calculated statistical empirical criterion, this value is less than the critical χ^2_{crit}=5.991. The EG and CG groups did not show significant differences at the initial stage of the experiment in the level of formation of the creative component of readiness.

We observed positive changes in EG respondents' creative abilities following completion of the experiment's formative stage.

The value of the Pearson criterion, which is statistical, indicates the presence of statistically significant differences after the completion of the experimental program

between the results of the respondents of the EG and CG in the levels of formation of the creative component of readiness (versus $\chi^2_{crit}=5.991-$ criterion $\chi^2_{emp}=7.577$).

During the ascertaining and formative experiments, the level of students' formation in the reflective-evaluative component of readiness was assessed through observation, testing, and ranking. Respondents in the EG and CG were asked, in writing, to evaluate and analyze their classmates' and their own activities during the lesson. The manifestations of respondents' activity were evaluated for logical coherence, objectivity, and the ability to comment and analyze. The results are presented in Table 5.

Table 5.
Dynamics of the levels of formation of the reflective-evaluative component of students' readiness for activity in the digital environment at the formative stage of the pedagogical experiment (%)

Level of formation	Reflective-evaluative component			
	Ascertaining stage		Formative stage	
	CG	EG	CG	EG
High Level	29%	28%	30%	44%
Average Level	33%	33%	39%	51%
Low Level	38%	39%	31%	5%

It is clear that the dynamics of the levels of readiness of the reflective-evaluative component have a positive direction upon completion of the experimental program. During the experimental work, our attention was focused on tasks with a creative subtext, problem-solving conversations, role-play modeling with a practice-oriented focus, disputes, dialogues, training sessions, business games, and related activities. The work carried out ensured positive dynamics in the CG experimental program.

The creation of a creative, positively favorable digital educational environment and the implemented pedagogical conditions provided each EG student with psychological comfort and psychological security, allowed, through the use of innovative various technologies, to take into account the development opportunities of each individual, his abilities, and readiness to work in a digital environment, satisfied the personal attitudes of EG students, contributed to the development of their creative actions, and had a qualitative impact on the formation of a multi-component structure of the readiness of future Human-Interaction Specialists by means of using digital technologies in professional activities.

The present study found statistically significant increases in both creative and reflective-evaluative components of professional readiness following the integration of digital technologies and AI-based tools. Specifically, the proportion of students with high levels of creative readiness increased from 10% to 29%, and reflective-evaluative readiness increased from 28% to 44% in the Experimental Group. These results align with and extend previous research that highlights the role of technology-enhanced environments in fostering higher-order thinking and metacognitive engagement.

Several studies have reported similar effects of digital and AI-supported learning on creativity. For example, Chen et al. (2025) demonstrated that adaptive learning systems can stimulate divergent thinking by presenting scaffolded problem-solving scenarios tailored to individual learner performance. Similarly, research on simulation-based learning environments indicates that interactive digital tools provide safe spaces for experimentation, reducing fear of failure and enabling

learners to explore novel solutions (Chaves & Gerosa, 2021). The current findings reinforce these observations, suggesting that digital affordances not only support task performance but also encourage creative exploration within professional contexts.

Regarding reflective-evaluative processes, our results corroborate the work of Zimmerman (2002), whose theoretical model of self-regulated learning emphasizes reflection as a core component of metacognition. AI-driven feedback mechanisms and automated progress tracking in this study likely supported students' ability to monitor and evaluate their own learning performance – an effect also documented in recent empirical research by Khasawneh et al. (2025), who found that learners using AI-enhanced e-portfolios engaged more consistently in reflective practice than those using traditional assessment formats.

However, some previous studies have reported more modest effects on reflective engagement, particularly when digital tools lacked structured prompts or pedagogical framing (Chan & Lee, 2021). This suggests that technology alone is insufficient; meaningful gains in reflection require intentional instructional design that guides learners through metacognitive cycles. The present study's pedagogical model, grounded in self-regulated learning and connectivist principles, may account for the stronger reflection outcomes observed, indicating that theoretical alignment between tools and learning processes is critical.

In summary, the observed improvements in creativity and reflection largely confirm existing literature on the pedagogical benefits of AI-supported and digitally enriched learning environments. These results highlight that when digital tools are integrated with theoretically grounded instructional strategies, they can effectively foster complex cognitive processes essential for professional readiness.

Conclusions

This study substantiates a theoretically grounded and empirically validated model for integrating digital technologies and artificial intelligence (AI) into the professional training of future Human-Interaction Specialists. The original contribution of the research lies in the development and experimental verification of a multi-component structure of professional readiness (motivational, procedural, creative, and reflective-evaluative), operationalized within a digitally transformed educational environment. Unlike predominantly technical studies of AI in education, this research integrates digital tools with pedagogical principles of systematicity, interactivity, individualization, integrativity, and reflection, thereby demonstrating how AI functions as a pedagogical instrument rather than merely a technological innovation. The empirical results confirm that structured implementation of AI-supported adaptive systems, simulations, digital assessment tools, and e-portfolios significantly enhances higher-order components of readiness, particularly creativity and reflective capacity. The study therefore contributes to the theoretical discourse on digital transformation in higher education by linking competence-based training with self-regulated and technology-mediated learning processes.

However, several limitations must be acknowledged. First, the quasi-experimental design and use of intact academic groups limit full randomization. Second, the sample was restricted to Ukrainian higher education institutions, which may affect cross-cultural generalizability. Third, the study measured short- to medium-term outcomes within the academic period, without assessing long-term professional performance. Additionally, reliance on percentage distributions and χ^2 analysis, while appropriate for categorical data, limits deeper causal modeling.

Future research should therefore:

− Conduct longitudinal studies to examine the sustainability of AI-supported competence development.
− Expand cross-institutional and cross-cultural samples.
− Apply advanced statistical modeling (e.g., structural equation modeling) to examine causal relationships between digital tool use and competence formation.
− Investigate the impact of AI integration on critical thinking, ethical decision-making, and professional identity formation.
− Explore the differential effects of specific AI tools (chatbots, adaptive systems, generative AI) on distinct components of professional readiness.

In sum, the findings confirm that theoretically aligned and pedagogically structured integration of digital technologies can significantly enhance professional training, while also highlighting the need for continued interdisciplinary and longitudinal investigation.

Bibliographic references

Beyan, C., Vinciarelli, A., & Del Bue, A. (2023). Co-located human–human interaction analysis using nonverbal cues: A survey. *ACM Computing Surveys, 56*(5), 109, 1–41. https://doi.org/10.1145/3626516

Bin-Hady, W. R. A., Al-Kadi, A., Hazaea, A. N., & Ali, J. K. M. (2023). Exploring the dimensions of ChatGPT in English language learning: A global perspective. *Library Hi Tech, 43*(4-5), 1315–1328. https://doi.org/10.1108/LHT-05-2023-0200

Bonami, B., Nocenzi, M., & Passarelli, B. (2020). Qualitative analysis of digital technology studies in the field of social and human sciences. *Journal of E-Learning and Knowledge Society, 16*(3), 50–59. https://doi.org/10.20368/1971-8829/1135241

Chan, C. K. Y., & Lee, K. K. W. (2021). Reflection literacy: A multilevel perspective on the challenges of using reflections in higher education through a comprehensive literature review. *Educational Research Review, 32*, 100376. https://doi.org/10.1016/j.edurev.2020.100376

Chaves, A. P., & Gerosa, M. A. (2021). How should my chatbot interact? A survey on social characteristics in human–chatbot interaction design. *International Journal of Human–Computer Interaction, 37*(8), 729–758. https://doi.org/10.1080/10447318.2020.1841438

Chen, R., Li, A. T., & Ma, T. (2025). Fostering divergent thinking via generative AI: The role of questioning-based learning. In *Proceedings of the International Conference on Information Systems (ICIS 2025)*. AIS Electronic Library. https://aisel.aisnet.org/icis2025/learn_curricula/learn_curricula/16

Chu, H.-C., Hwang, G.-H., Tu, Y.-F., & Yang, K.-H. (2022). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology, 38*(3), 22–42. https://ajet.org.au/index.php/AJET/article/view/7526

Ciampi, M. M., Brito, C. R., Feldgen, M., & Clua, O. (2025). Plenary: Education in the age of generative AI: Embracing digital transformation. In *2025 IEEE Engineering Education World Conference (EDUNINE)* (pp. 1–4). Montevideo, Uruguay. https://doi.org/10.1109/EDUNINE62377.2025.10981392

Farias-Gaytan, S., Aguaded, I., & Ramírez-Montoya, M. S. (2023). Digital transformation and digital literacy in the context of complexity within higher education institutions: A systematic literature review. *Humanities and Social Sciences Communications, 10*(1). https://doi.org/10.1057/s41599-023-01875-9

Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2024). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International, 61*(3), 460–474. https://doi.org/10.1080/14703297.2023.2195846

Gutiérrez, F. J., Magallanes, Y., Gaytán-Lugo, L. S., López, C., & de Souza, C. R. B. (2019). Academic viewpoints and concerns on CSCW education and training in Latin America. *Proceedings of the IX Latin American Conference on Human-Computer Interaction, 1–4*. https://doi.org/10.1145/3358961.3358971

Hamdan-Mansour, R. A., Abu Hardan, F. A., Alayasrah, M. A., Al Nabulsi, H. M., Fawaz, M., Hamdan-Mansour, A. M., & AboHanana, R. B. (2026). The association between artificial intelligence and health specialty students' critical thinking, clinical competency, and willingness to practice human interaction skills. *BMC Medical Education, 26*, 133. https://doi.org/10.1186/s12909-025-08453-4

Haristiani, N. (2019). Artificial intelligence (AI) chatbot as language learning medium: An inquiry. *Journal of Physics: Conference Series, 1387*(1), 012020. https://iopscience.iop.org/article/10.1088/1742-6596/1387/1/012020/pdf

Khasawneh, M. A. S., Aladini, A., Assi, S. A., & Ajanil, B. (2025). Portfolio assessment in AI-enhanced learning environments: A pathway to emotion regulation, mindfulness, and language learning attitudes. *Language Testing in Asia, 15*, 5. https://doi.org/10.1186/s40468-025-00345-0

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

Ouyang, F., Zheng, L., & Jiao, P. (2022). Artificial intelligence in online higher education: A systematic review of empirical research from 2011 to 2020. *Education and Information Technologies, 27*(6), 7893–7925. https://doi.org/10.1007/s10639-022-10925-9

Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? *Journal of Applied Learning and Teaching, 6*(1), 342–363. https://doi.org/10.37074/jalt.2023.6.1.9

Shen, H., & Wang, M. (2023). Effects of social skills on lexical alignment in human–human interaction and human–computer interaction. *Computers in Human Behavior, 143*, 107718. https://doi.org/10.1016/j.chb.2023.107718

Tzirides, A. O., Zapata, G., Kastania, N. P., Saini, A. K., Castro, V., Ismael, S. A., You, Y., Afonso dos Santos, T., Searsmith, D., O'Brien, C., Cope, B., & Kalantzis, M. (2024). Combining human and artificial intelligence for enhanced AI literacy in higher education. *Computers and Education Open, 6*, 100184. https://doi.org/10.1016/j.caeo.2024.100184

Xia, H., Chen, J., Qiu, Y., Liu, P., & Liu, Z. (2025). The impact of human–chatbot interaction on human–human interaction: A substitution or complementary effect. *International Journal of Human–Computer Interaction, 41*(2), 848–860. https://doi.org/10.1080/10447318.2024.2305985

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2