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INTEGRATING GENERATIVE AI INTO HEURISTIC APPROACHES TO FOREIGN LANGUAGE EDUCATION

ІНТЕГРАЦІЯ ГЕНЕРАТИВНОГО ШТУЧНОГО ІНТЕЛЕКТУ В ЕВРИСТИЧНІ ПІДХОДИ ДО НАВЧАННЯ ІНОЗЕМНИХ МОВ

The article critically analyzes and scientifically substantiates the paradigm of integrating modern information and communication technologies (ICT) and artificial intelligence (AI) tools into the system of heuristic foreign language teaching in higher education. The author demonstrates that the synergy of digital tools and generative AI serves as a powerful intensifier of the educational process, ensuring deep individualization, differentiation of learning, enhancement of students' intrinsic motivation, and the development of their cognitive and creative autonomy.

The study synthesizes practical experience in utilizing the digital ecosystem of Sumy State Pedagogical University named after A.S. Makarenko in combination with video conferencing services (Google Meet, Zoom) and adaptive AI technologies to organize flexible online learning. Particular attention is paid to the effectiveness of these tools under crisis conditions (the COVID-19 pandemic and martial law) both for the routine automation of assessment and for modeling open-ended creative tasks of an exploratory nature.

The paper presents original methodological developments, including the electronic manual «Communicative Culture of Medical Students in Use», integrated with modern digital resources. Specific examples demonstrate how the use of ICT and AI assistants enables students to complete a full heuristic cycle: from analytical information processing to the generation, self-correction, and defense of their own original educational product. The author summarizes the undeniable advantages of the updated innovative higher education space, which transforms traditional subject-subject relations into a format of interactive partnership: "teacher – student – artificial intelligence".

Key words: information and communication technologies, innovative pedagogical technologies, heuristic education, independent work, educational product, presentation, educational platform.

У статті критично проаналізовано та науково обґрунтовано парадигму інтеграції сучасних інформаційно-комунікаційних технологій (ІКТ) та інструментів штучного інтелекту (ШІ) у систему евристичного навчання іноземних мов у вищій школі. Автор демонструє, що синергія цифрових інструментів та генеративного ШІ слугує потужним інтенсифікатором освітнього процесу, забезпечуючи глибоку індивідуалізацію, диференціацію навчання, підвищення внутрішньої мотивації студентів, а також розвиток їхньої когнітивної та творчої автономії. У дослідженні синтезовано практичний досвід використання цифрової екосистеми Сумського державного педагогічного університету імені А. С. Макаренка в поєднанні з сервісами відеоконференцзв'язку (Google Meet, Zoom) та адаптивними технологіями ШІ для організації гнучкого онлайн-навчання. Особливу увагу приділено ефективності цих інструментів у кризових умовах (пандемія COVID-19 та воєнний стан) як для рутинної автоматизації оцінювання, так і для моделювання відкритих творчих завдань дослідницького характеру. У роботі представлено оригінальні методичні розробки, зокрема електронний посібник «Communicative Culture of Medical Students in Use», інтегрований із сучасними цифровими ресурсами. На конкретних прикладах продемонстровано, як використання ІКТ та ШІ-асистентів дозволяє студентам пройти повний евристичний цикл: від аналітичної обробки інформації до генерації, самокорекції та захисту власного оригінального

освітнього продукту. Автор узагальнює незаперечні переваги оновленого інноваційного простору вищої освіти, який трансформує традиційні суб'єкт-суб'єктні відносини у формат інтерактивного партнерства: «викладач – студент – штучний інтелект».

Ключові слова: інформаційно-комунікаційні засоби навчання, інноваційні педагогічні технології, евристичне навчання, самостійна робота, освітній продукт, презентація, навчальна платформа.

Introduction to the Problem. The modern national education system in Ukraine demands novel approaches to training future specialists. It must be directed toward overcoming the educational crisis, which manifests primarily in the mismatch between students' knowledge, personal aspirations, societal needs, and global standards. Given the urgent need to reconceptualize the overall content of education, there is a vital necessity to seek and implement innovative, effective methods and technologies for foreign language teaching in higher education institutions. This will significantly align Ukraine's educational realities with European and global standards.

The unprecedented crisis caused by the COVID-19 pandemic and the full-scale invasion of the Russian Federation has demonstrated the vital role of ICT. The world is experiencing accelerated digitalization across various activities and services, including teleworking systems and video conferencing in and beyond the workplace. Today, it is no longer possible for a higher education institution to remain isolated from digital transformation; digitalization has become the defining trend of the modern educational system.

ICTs are developing highly dynamically, and the methodology of their application in the educational process must evolve just as rapidly. Modern ICTs encompass internet technologies, multimedia software, office and specialized software, electronic textbooks, video conferencing platforms, and distance learning platforms (computer-assisted learning support systems). Crucially, this digital toolkit has recently been augmented by generative artificial intelligence (AI) technologies, which are transforming traditional educational formats into adaptive, personalized environments.

However, the insufficient development of this issue and the contradictions between the vast potential of ICT and AI, and the way they are actually applied in the classroom—often limited to closed-ended, rote tasks—hinder the effective creative development of future specialists. Modern professional demands require graduates to possess advanced, creative professional skills, such as designing, constructing, organizing, and communicating. On the path to resolving this problem theoretically and practically, several contradictions persist: – the gap between the societal recognition of the role and

capabilities of ICT/AI and the insufficient theoretical justification of the goals and objectives of their application in fostering creative personality development within the humanities; – the contradiction between the orientation of higher pedagogical education toward creating a modern learning environment (especially under the crisis conditions of the COVID-19 pandemic and martial law) and the lack of balanced, practical frameworks for establishing such an environment; – the mismatch between the goal of raising a specialist's creative capacity and their insufficient engagement with ICT and AI tools in the course of autonomous cognitive and creative activities.

One promising solution to resolve these contradictions is the strategic integration of ICT and AI tools with heuristic learning technologies. This approach empowers students to choose their own learning pace and design personally meaningful educational products, which heuristic education views as the primary goal of the learning process. With generative AI acting as an interactive partner, simulator, and cognitive scaffold, educators who master the competent management of students' autonomous cognitive and creative activities report powerful potential and an irreplaceable role of heuristic technologies in successful education, particularly in foreign language learning.

Educational modernization occurs not only through innovative pedagogical technologies but also through computerization and the deployment of information, communication, and intelligence-driven tools in the classroom. A modern foreign language teacher must do more than just operate ICT devices; they must skillfully synthesize new pedagogical technologies, contemporary methods, and novel organizational forms of learning. Under these circumstances, special attention must be paid to training educators to utilize existing tools, develop their own, and test newly created digital and AI-assisted educational resources, verifying their feasibility within specific pedagogical systems.

In an educational landscape heavily transformed by informational, heuristic, modular, and other innovative technologies of humanistic learning, the problems of teaching foreign languages using ICT and AI within a heuristic learning framework remain insufficiently explored.

Literature Review (Analysis of Recent Research and Publications). The study of the specific aspects of utilizing ICT in education has been the focus of numerous scientific inquiries. The general principles of organizing the educational process with the help of information and communication tools are outlined in the Decree of the Ministry of Education and Science of Ukraine “On the Rules for Using Computer Programs in Educational Institutions” [4] and the Resolution of the Cabinet of Ministers of Ukraine “On Approving the State Program ‘Information and Communication Technologies in Education and Science’” [2].

Domestic researchers such as V. Oliinyk and V. Kukharenko have focused on the theoretical and methodological foundations of distance education in higher education institutions (HEIs) and adult training. The development, implementation, and evaluation of the effectiveness of modern software-based pedagogical tools have been studied by V. Redko and L. Kartashova. A profound analysis of the concept of electronic learning tools has been carried out by D. Chernylevskyi, I. Bohdanova, O. Spirina, O. Bashmakova, I. Robert, M. Zhaldak, I. Markhel, Ye. Polat, A. Osina, and others.

The analysis of scientific and pedagogical literature indicates that researchers view the integration of ICT into the educational process through several key dimensions:

- The establishment of an information environment: R. Hurevych, O. Ovcharuk, L. Chernikova, and others;
- The content, forms, and means of utilizing ICT in the educational system: I. Voitovych, O. Hrytsenchuk, M. Zhaldak, S. Ivanova, and others;
- Strategies for ensuring the effective use of ICT in education: L. Kartashova, N. Morze, O. Ovcharuk, among others.

Among international scholars, the challenges of ICT in education have been investigated by M. Gavrilova, I. Zakharova, M. Moiseeva, A. Petrov, Ye. Polat, and others.

Furthermore, the potential of using the Internet for lesson preparation and delivery is being actively explored by N. Vovkovinska and L. Kalyndruz (Internet communication), V. Anaka (e-mail), O. Voichenko and A. Solopov (Internet search engines), V. Bazuryn and I. Zakomirnyi (website design), V. Ishtukiv (effective use of local networks in the learning process), as well as O. Danylova, V. Monako, and D. Monako (multimedia design and application).

To date, significant experience has been accumulated regarding the use of computer technologies and

educational software in classrooms, allowing educators to recognize both their strengths and weaknesses. With the recent rapid advent of generative artificial intelligence (AI) and intelligent tutoring systems (ITS), this experience is being dynamically reshaped, adding new layers of adaptivity and interactive scaffolding to the digital educational environment.

The works of V. Oliinyk are dedicated to the theoretical and methodological foundations of distance learning for adults, while V. Kukharenko examines the theoretical and methodological aspects of distance learning in higher education. The design, implementation, and analysis of the efficiency of modern pedagogical software are investigated by V. Redko.

Scholars such as S. Fadeev, O. Uvarov, I. Horodyskyi, and E. Skybytskyi note that the rapid development and implementation of ICT in daily life and education compel foreign language educators to address challenges that, twenty years ago, no linguist could have even imagined. Unsurprisingly, not every teacher has proven fully prepared for the active implementation of ICT—and now, sophisticated AI tools—into such an unconventional sphere as foreign language teaching.

In recent years, immense attention has been paid to the computerization of foreign language teaching. This is evident in the scholarly works of A. Hurzhii, O. Zymyina, O. Vilshynetska, P. Monastyrov, Ye. Polat, V. Revenko, O. Tarnapolskyi, T. Gaskey, B. Reaves, and K. Windschitl.

L. Kartashova asserts that an educator’s use of ICT in foreign language teaching allows for an effective and accessible presentation of new learning material; demonstrates connections between the curriculum and history or intriguing facts from the lives of prominent figures; provides practical examples of foreign language application; and facilitates the implementation of problem-based and heuristic learning [3]. Today, these pedagogical affordances are significantly amplified by generative AI, which can instantly customize content, generate personalized case studies, and act as an interactive conversational partner.

The issues of using ICT to enhance the effectiveness of students’ autonomous work are explored in the studies of N. Boiko and A. Bairakivskyi. They emphasize that the integration of ICT into the educational process fosters a more comprehensive mastery of knowledge and skills, stimulates the creative orientation of students’ cognitive activities, and aids in shaping key professional and personal qualities [1].

Crucially, the deployment of ICT and AI tools in higher education is not an end in itself, but rather a pedagogically justified approach that must offer clear instructional advantages over traditional methods of organizing autonomous study.

Nevertheless, existing scientific and methodological literature still pays insufficient attention to the feasibility of using ICT alongside emerging AI technologies specifically for developing the creative potential of a student's personality during foreign language acquisition. There is a notable gap in research regarding how these advanced tools can be leveraged to engage students in heuristic tasks designed to motivate autonomous cognitive-creative activity and lead to the creation of personally meaningful, creative educational products.

The Objective of the Article. The objective of the article is to identify and analyze the positive synergy between the application of information and communication technologies (ICT), including emerging artificial intelligence (AI) tools, and modern innovative pedagogical technologies, specifically heuristic learning, in the process of foreign language acquisition.

The Core Material Presentation. Information and communication technologies (ICT) in education are oriented toward the individualization of learning and students' autonomous self-educational activities. Student-centered learning of a heuristic nature, along with its innovative technologies, methods, and tools, emphasizes the organization of independent creativity aimed at generating a freely chosen and personally meaningful educational product, which serves as a decisive factor in the successful self-realization of the individual.

The integration of ICT and generative AI tools in heuristic foreign language teaching accelerates the dynamics of the educational process, stimulates students' cognitive interest in acquiring new knowledge, organizes their fruitful creative and exploratory work, and fosters self-directed educational activity. In this context, AI acts as an adaptive intellectual partner that does not simply provide ready-made answers but scaffolds the student's inquiry process, encouraging deeper linguistic exploration.

Consequently, this educational approach facilitates deep individualization and differentiation of learning, enhances students' intellectual capacities, and increases the emotional reception of academic information by significantly improving the visualization of the study material. Advanced digital tools and AI-driven systems enable the visualization of complex syntactic and semantic structures, the modeling

and exploration of diverse linguistic and cultural phenomena, and offer unlimited opportunities for repeated access to learning content. Furthermore, they provide interactive scaffolding through hyper-linking, online dictionaries, and real-time AI-powered feedback to achieve a profound comprehension of the subject matter.

– The organization of heuristic foreign language teaching utilizing ICT and AI technologies is grounded in several fundamental didactic principles:

– The reinforcement of subject-subject relations, which are further enriched by interactive human-AI collaboration;

– The priority of autonomous cognitive and creative activity;

– The motivational support of independent study;

– A goal-oriented focus on the independent creation of a student's freely chosen and personally meaningful educational product;

– The achievement of productive co-creativity between educators and students based on heuristic dialogic interaction;

– The continuous diagnostics and evaluation of the progress and outcomes of autonomous work through a highly refined, criteria-based assessment framework.

Modern educational technologies, particularly heuristic learning, combined with ICT and artificial intelligence (AI) tools, ensure the continuity of the learning process, provide comprehensive theoretical materials, organize training activities, and facilitate knowledge assessment. Through these digital solutions, students successfully realize their creative potential at every stage: from acquiring theoretical knowledge and its practical testing to hands-on training and the autonomous design and evaluation of their final educational products. AI-powered adaptive learning platforms allow for customized lesson formats and enable students to navigate the material along a highly personalized learning trajectory, which is a key principle of heuristic education.

As the creative component of higher education gains greater prominence, the roles of all participants in the educational process are shifting to foster students' investigative autonomy. Consequently, the concepts of interactive and heuristic learning supported by computer-based systems are becoming increasingly relevant. In this digital educational environment, students can communicate with the instructor online, solve creative and problem-based tasks, and simulate real-world scenarios while actively engaging their analytical and critical thinking, existing

knowledge, and inquiry skills. Here, generative AI acts as a sophisticated partner, prompting students with complex queries rather than simple answers, thereby stimulating deeper cognitive processing.

In European and American educational frameworks, Inquiry-Based Learning (IBL) is widely and effectively applied [12, 7]. This method encourages students to construct new knowledge independently by searching for answers to open-ended questions and formulating their own inquiries to resolve creative educational tasks. Within this strategy, students actively acquire knowledge through independent research [8]. This pedagogical model is designed to develop students' skills in analysis, synthesis, and evaluation [8], which, according to Bloom's Taxonomy of Educational Objectives, corresponds to the highest levels of critical thinking. The integration of generative AI within IBL models offers unprecedented scaffolding, as intelligent agents can simulate diverse research scenarios and challenge students to refine their hypotheses.

The hypothesis of our study is based on the assumption that utilizing ICT and AI technologies in heuristic foreign language teaching significantly improves the quality of knowledge, enhances creative skills, and increases overall student performance.

In the heuristic learning model, considerable emphasis is placed on activities designed to develop a student's ability to identify problems, propose hypotheses for their resolution, independently construct arguments, draw logical conclusions from facts, and design plans to verify them. Throughout this heuristic process, the educator acts as a facilitator, encouraging collaboration and empowering students to act independently, seek new knowledge, and hone their creative capacities.

Under this heuristic paradigm, students construct their knowledge of the subject matter by drawing upon their personal educational potential, the digital learning environment, and the heuristic framework designed by the teacher. The resulting educational product (whether it is newly acquired knowledge, practical experience, a hypothesis, an essay, or a presentation—potentially co-created or refined using AI assistants) is subsequently compared, with the instructor's guidance, to cultural and historical analogues or the products of other students. Through this comparative analysis, the student's work is re-evaluated, expanded, or restructured as needed. In this educational framework, the personal academic and creative growth of the student (encompassing their knowledge, skills, competencies, and tangible creations) is primary and inevitable [5].

The proposed model of heuristic foreign language teaching utilizing ICT and AI technologies is developed in accordance with the fundamental principles of heuristic education. It encompasses mandatory tasks facilitated primarily by the educator to provide external stimulation, while fundamentally relying on students' individual, variable goal-setting, task definition, and the subsequent creation of their own educational products. Within this framework, generative AI tools serve as cognitive scaffolds, assisting students in brainstorming, structuring, and refining these personalized goals and creative outputs.

In processing foreign language materials, particularly for professional purposes (ESP), the personal mobile devices of both students and educators are widely utilized. With the integration of mobile-friendly AI applications, smart dictionaries, and intelligent grammar assistants, users can quickly obtain contextual translations, explore semantic nuances, search for supplementary thematic information, and independently master complex grammatical structures on the go.

The study confirmed the hypothesis that the application of ICT and AI within innovative pedagogical frameworks—specifically heuristic learning—undoubtedly improves the quality of acquired knowledge and skills while enhancing overall student performance. A key milestone of this research was identifying qualitative advancements in students' competencies, particularly their ability to creatively reimagine acquired knowledge and actively deploy it to design, construct, correct, and refine their own educational products (aligned with the criteria established for each type of output). AI-powered proofreading and feedback tools played a crucial role in this cycle by providing immediate, formative suggestions for ongoing self-correction and stylistic enhancement.

Information and communication technologies, augmented by AI capabilities, allow for a seamless synthesis of cognitive-creative learning methods. This enables students to search for, analyze, and transform educational data, ultimately creating personally meaningful educational products and presenting them via digital media.

Ultimately, the more effectively a student's autonomous cognitive activity is organized, the more efficient and qualitative the overall learning process becomes. Digital and AI-assisted learning tools significantly elevate students' autonomy, which is essential for translating external information into internal, personal knowledge. This is because only deeply processed, actively transformed, and critically evaluated (frequently through interactive dialogue

with AI systems) knowledge becomes truly meaningful and firmly consolidated.

Modern society requires not only an information-literate individual but also a creative, independent personality. Therefore, it is essential to foster students' autonomy and creative capacities. This task can be effectively accomplished through digital technologies, specifically by engaging students in the collaborative development of electronic textbooks for their educational institutions. With the integration of generative AI as an assistive co-creator, the process of designing an electronic textbook facilitates close collaboration between the instructor and students. Together, they curate content, segment it into thematic modules, design the textbook's interactive structure, and generate high-quality visual illustrations. Under these collaborative conditions, one of the core principles of heuristic learning—the subject-subject-object interaction among participants, now extended to a “teacher – student – AI” partnership—is fully realized.

The workflow of creating an electronic textbook closely mirrors the project-based learning (PBL) methodology. A skillful combination of gamified, interactive methods and ICT tools—including AI-driven collaborative platforms—fosters interpersonal and group communication aimed at knowledge acquisition and exchange, which is an indispensable component of heuristic education. Instructors employ aligned pedagogical strategies and methods focused on the successful achievement of a shared, tangible result.

These technologies are highly effective for introducing new material, as visual imagery stimulates memory and imagination. In foreign language acquisition, particularly through AI-generated contextual imagery and multimedia resources, it helps students directly link the target language vocabulary with real-world objects and concepts, bridging them with their native Ukrainian language. Furthermore, the application of interactive electronic presentations enables a sequential, logical organization of both classroom instruction and students' autonomous study.

Additionally, the delivery of online classes via Google Meet and Zoom platforms has revealed that

students who are traditionally passive during face-to-face interactions often become highly active in the virtual learning space. It has been observed that interacting through digital communication platforms feels significantly easier, more accessible, and more engaging for them. This digital environment, especially when enhanced by real-time AI writing assistants and instant feedback mechanisms, allows students to support one another via chat, retrieve complementary information from diverse digital sources on the fly, and substantially reduces the affective filter—lowering the fear of making linguistic mistakes.

Conclusions. Thus, the integration of information and communication technologies within the framework of heuristic foreign language teaching highlights several key affordances: the student independently selects the location, timing, and pace of their learning, gains open access to information, and is empowered to practice and self-assess their knowledge, skills, and competencies. The inclusion of generative AI as an adaptive learning partner further elevates this autonomy, offering personalized feedback and tailored pathways for self-correction. Furthermore, the widespread adoption of mobile devices (BYOD – Bring Your Own Device) by both students and educators, alongside the utilization of modern digital learning platforms and AI-assisted tools, expands the volume of acquired information, stimulates students' active engagement, simplifies assessment procedures, and fosters a truly innovative educational environment.

Prospects for Further Research. Nevertheless, several challenges remain open and warrant further investigation. There is an ongoing need to develop and refine comprehensive methodological guidelines for designing electronic foreign language curricula, particularly for internal institutional use. Future research should also focus on establishing pedagogical frameworks for the ethical, secure, and effective integration of generative AI tools within these digital curricula, ensuring they continue to serve as cognitive scaffolds for students' autonomous, creative, and heuristic growth.

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