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Interactive Methods of Teaching Foreign Languages in Technical Higher Education Institutions

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Abstract

The aim of the article is to study the theoretical and methodological foundations and empirical substantiation of the feasibility of introducing interactive methods and artificial intelligence tools into the process of teaching foreign languages in technical institutions of higher education, as well as to develop a structural and functional model of their integration into the professionally oriented training of future engineers. Methods: a complex of theoretical (systemic, comparative, content analysis of scientific sources) and empirical methods was applied – analysis of official Eurostat statistical data, OECD and UNESCO reports; calculation of the aggregate index of digital-AI-educational activity; correlation analysis of the relationship between the level of digital competence and academic success; pedagogical modeling. Data collection was carried out through a systematic review of scientific publications (from the Web of Science / Scopus databases) and official statistical products of Eurostat and OECD for the period 2022–2026. Data analysis was performed using thematic coding, comparative analysis, correlation analysis (Pearson coefficient) and structural-functional modeling. As a result, a stable positive dynamics of the use of online learning and generative AI by young people in EU countries was revealed (growth by 5.5 pp for 2022–2024), a direct correlation between the level of education and digital skills was confirmed (correlation coefficient with success r=0.67–0.71). A structural-functional model of the implementation of interactive methods in technical higher education was developed, which covers target, content, procedural, technological and assessment components, ensuring the integration of linguistic, professional and digital competencies.

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Introduction

The virtualization of higher education and the fast domino effect of generative artificial intelligence are altering the rationality of professional training of future engineers, especially regarding the foreign language communication as the means of worldwide scholarly and industrial communication. In technical higher education institutions, the problem lies in the need to combine the professional orientation of language training with interactive forms of learning and digital tools that correspond to the level of technological competence of students. Current research confirms the effectiveness of interactive scenarios, digital platforms, and AI applications in developing autonomy, motivation, and readiness for communication (Karataş et al., 2024; Liu, 2025; Torres & Kahveci, 2025; Mialkovska et al., 2023, 2025; Martyniuk et al., 2023), and emphasize the importance of pedagogical mediation and the formation of soft skills in a technical language environment (Kats et al., 2024; Medvedeva & Rubtsova, 2021; Kyseliuk et al., 2020). At the same time, at the macro level, there has been an increase in online learning and the use of generative AI by young people in EU countries (Eurostat, 2025a, 2026; OECD, 2026), which creates new opportunities and, at the same time, poses methodological challenges. Despite a significant number of studies, a comprehensive model for integrating interactive and AI-supported methods in a technical university, taking into account interdisciplinary connections and measurable indicators of digital activity, remains underdeveloped. The aim of this work is to investigate the theoretical and methodological foundations and empirically justify the feasibility of introducing interactive and AI tools into the process of teaching foreign languages at technical higher education institutions and to develop a structural and functional model for their integration into the professionally oriented training of future engineers.

International research in recent years convincingly demonstrates that the effectiveness of foreign language training in technical universities is largely determined by the degree of integration of interactive digital environments and artificial intelligence tools. Thus, Hamdani and Ouahmiche (2022) using the example of training hydraulic engineers proved that authentic materials and communicative scenarios, close to real professional situations, significantly increase students' motivation and practical readiness for professional communication. Karyuatry et al. (2020) in their study emphasized the importance of using authentic materials for the development of oral communication, which is especially relevant for engineering specialties, where communication takes place in an interdisciplinary context. In addition, Winn& Beck (2018) showed that international virtual collaboration within English for Specific Purposes (ESP) increases the authenticity of the educational process and contributes to the formation of intercultural interaction skills. These international developments confirm the need for systematic implementation of interactive technologies in technical higher education institutions, however, the issue of a comprehensive model that would combine AI tools, professionally oriented scenarios, and statistically confirmed performance indicators remains insufficiently researched.

Therefore, the aim of the work is to investigate the theoretical and methodological foundations and empirically substantiate the feasibility of introducing interactive methods and AI tools into the process of teaching foreign languages in technical higher education institutions, as well as to develop a structural and functional model of their integration into the professionally oriented training of future engineers. In accordance with the aim, the following research questions were posed:

1. What are the current statistical trends in the digitalization of education and the use of generative AI observed in EU countries and how do they correlate with the level of digital competence of students of technical specialties?
2. What didactic capabilities of interactive technologies and AI tools are most relevant for the formation of professionally oriented foreign language competence of future engineers?
3. How to structure the model of introducing interactive methods in technical higher education institutions to ensure the integration of language, digital and professional training?
4. What is the relationship between the level of digital competence, the use of AI tools, and the

academic performance of students in technical specialties?

Literature Review

Contemporary research on interactive and digitally oriented foreign language teaching in higher education institutions demonstrates a systematic transition from the traditional translation model to an activity-based and competence-oriented paradigm with active integration of digital technologies and artificial intelligence (Mialkovska et al., 2025). In the context of professionally oriented language training, the role of English as a tool for professional mobility and industry communication is emphasized (Asafo-Adjei et al., 2025; Oria Alonso & Pérez Fernández, 2025; Wang et al., 2023), which is especially relevant for technical universities.

The theoretical foundations of interactive learning are based on the concepts of pedagogical mediation, the development of critical thinking, and the formation of soft skills in a professionally oriented environment (Kats et al., 2024; Bocharova, 2026; Medvedeva & Rubtsova, 2021; Kyseliuk et al., 2020). Studies on the implementation of online courses at technical universities confirm the effectiveness of hybrid learning models that combine digital platforms and project-based interaction (Mendygalieva et al., 2024; Stefanovic & Klochkova, 2021; Leva et al., 2025). At the same time, interactive scenarios have a positive effect on students' willingness to communicate and accept technologies (Estrada-Chichón et al., 2023; Cui et al., 2025; Piro et al., 2025).

A separate body of scientific works is devoted to the integration of artificial intelligence systems into foreign language education. It has been proven that the use of ChatGPT and other AI tools contributes to increased autonomy, motivation, and quality of written and oral practice (Karataş et al., 2024; Mohamed, 2023; Xiao & Zhi, 2023; Yan, 2023). The issues of AI's effectiveness, pedagogical relevance, and transformational potential are considered both from the perspective of personalizing learning (Bai, 2025; Torres & Kahveci, 2025; Vo, 2025) and from the perspective of balancing innovation and academic integrity (Zadorozhnyy & Lai, 2024; Tran, 2025; Klimova & Pikhart, 2025). The specifics of AI application in technical universities are detailed in works devoted to engineering education and the integration of technological environments into language courses (Hamdani & Ouahmiche, 2022; Trokhymchuk et al., 2025).

The macro-level context of the digitalization of education is reflected in analytical materials from international organizations, which record the growth of online learning, the development of digital competencies, and the spread of generative AI in educational practice (Eurostat, 2024a, 2024b, 2025a, 2025b, 2026; OECD, 2025, 2026; UNESCO, 2023). Statistical data show a direct correlation between the level of education and digital skills, as well as the gradual institutional consolidation of digital technologies in the educational process, which creates the basis for the systematic integration of interactive and AI-supported models in technical higher education institutions.

Further analysis of scientific sources shows that the issue of introducing interactive methods in technical universities is also considered through the prism of an engineering-oriented context of learning and adapting language training to the specifics of technical specialties. In particular, the issues of teaching engineering disciplines in English and interlingual integration in professional training are explored in the studies by Oria Alonso and Pérez Fernández (2025) and Wang et al. (2023), which emphasize the need to combine linguistic, professional, and intercultural competencies. At the same time, the works of Trokhymchuk et al. (2025) focus on the implementation of AI technologies directly in foreign language courses for engineers, which expands the possibilities for modeling professional situations.

The issue of using generative AI in the formation of writing competence and the development of editing skills is highlighted in the studies by Tran (2025), Yan (2023), and Zadorozhnyy and Lai (2024), which demonstrate both the positive impact of AI feedback and the risks of superficial assimilation of material. An analysis of the experience of using ChatGPT in language tasks confirms the transformation of the learner's role from a passive consumer to an active co-creator of text (Xiao & Zhi, 2023; Mohamed, 2023).

In turn, Klimova and Pikhart (2025) emphasize the need for pedagogically regulated implementation of AI in the educational process to avoid methodological fragmentation.

Studies on the impact of digital and interactive tools on learners' knowledge, skills, attitudes, and motivation confirm their positive effect when integrated in a methodologically sound manner (Piro et al., 2025; Leva et al., 2025; Liu, 2025). At the same time, the works of Cui et al. (2025) and Estrada-Chichón et al. (2023) prove that it is the nature of interactive scenarios that determines the level of acceptance of technologies and readiness for foreign language communication. In the context of developing professionally relevant skills, a productive teaching method that ensures the formation of soft skills in a technical foreign language environment (Winn & Beck, 2018; Medvedeva & Rubtsova, 2021) and visual strategies for developing critical thinking (Bocharova, 2026) are of particular importance.

At the macro level, analytical reports from international organizations record the systematic digital transformation of education and the spread of online learning and AI tools in EU countries (Eurostat, 2024a, 2024b, 2025a, 2025b, 2026; OECD, 2025, 2026; UNESCO, 2023). These data correlate with conclusions about the need for structural modernization of educational models at technical universities, taking into account the growth of digital competence among young people and the integration of generative AI into the educational process.

Thus, a summary of current research indicates the multidimensional nature of scientific discourse: from pedagogical mediation and the development of critical thinking to personalized AI systems and statistically confirmed digitalization of education. Simultaneously, the earlier research failed to provide an adequate development of an elaborate structural and functional paradigm of incorporating interactive techniques and generative AI within the framework of the technical higher education and considering the interdisciplinary relationships. Moreover, the matter of holistically assessing the effects of interactive and AI-assisted environments on the professional communication preparedness of the engineers of the future has not been empirically proven.

Method

Research design

The study has a mixed theoretical-empirical design, which combines a systematic review of scientific literature, analysis of official statistical data of international organizations and pedagogical modeling. Such a design allows, on the one hand, to generalize modern theoretical approaches to interactive foreign language teaching in technical higher education institutions, and on the other hand, to quantitatively confirm macrotrends of digitalization of education and substantiate the structural and functional model of the implementation of interactive methods.

Sampling

The samples comprised publications from the Web of Science, Scopus, Google Scholar databases for the period 2020–2026; Eurostat statistical data sets for 2022–2026; OECD and UNESCO analytical reports; educational programs of 6 technical universities of Ukraine and 4 foreign ones (Poland, Germany, Finland, Slovakia) according to the criteria of integration of digital and interactive methods.

Data collection tools

Data collection was carried out through: systematic search in scientometric databases using keywords: «interactive methods», «foreign language teaching», «technical university», «artificial intelligence in education», «digital competence»; extraction of numerical indicators from open Eurostat databases (percentage of the population that took online courses, used generative AI) with subsequent normalization and unification; content analysis of curricula of technical higher education institutions to identify the presence of interactive modules, AI tools and project tasks.

Data analysis

Data analysis was performed in several stages:

- thematic content analysis of scientific sources to identify key didactic approaches and tools;
- calculation of an aggregate index of digital-AI-learning activity, where the weights are determined based on the frequency of mentions in the analyzed sources;

- correlation analysis (Pearson coefficient) between the level of digital competence, the use of AI tools and academic performance (according to TALIS 2024 and OECD Digital Education Outlook 2026);
- structural-functional modeling to build a conceptual model of the implementation of interactive methods in technical higher education. To ensure the reliability of the results, triangulation of sources and independent coding by two researchers were used.

Results

In their theoretical and methodological analysis of the application of interactive methods in teaching foreign languages in technical higher education institutions, one should conduct the work at the nexus of communicative, competency-based, constructivist, and digitally integrative approaches. The program of training in foreign language in technical higher education has very specific professional orientation which predetermines the re-orientation of the traditional translational pattern of teaching to the activity-based interactive pattern of training, in which the learner is the active participant of the knowledge-building process in simulated professional conditions. Constructivist paradigm entails learning by working together, problematizing and reflecting, which is put in place as case studies, role plays, imitating technical meeting, and integrating interdisciplinary projects in English. In this context, interactivity is not only a methodological characteristic of the lesson, but also a tool for forming the professional communicative autonomy of future engineers.

The competency-based approach in technical higher education institutions is specified through the integration of foreign language, digital, and professional competencies. Interactive methods allow for the synchronization of language training with professional disciplines, in particular through the analysis of technical documentation, the preparation of presentations of engineering solutions, and participation in debates on innovative technologies. In this regard, the concept of pedagogical mediation is significant, which involves the organization of a communicative space by the teacher as a facilitator who coordinates interaction, provides feedback, and stimulates critical thinking (Karyuatry et al., 2020; Kats et al., 2024). Methodologically, this means a transition from a directive model to a cooperative model of learning process management.

Modern digital transformations in the educational environment are leading to a rethinking of interactivity as a technologically supported phenomenon. The use of smart platforms, LMS, interactive cloud services, and AI assistants expands the boundaries of classroom interaction and creates hybrid communication formats. Research on the digitization of learning shows that integrating smart platforms into the foreign language teaching process positively affects student satisfaction and increases the effectiveness of the educational process (Stefanovic & Klochkova, 2021). This concerns technical institutions of higher learning particularly because students are very much digitally literate and demanding of a learning environment that is rich in technology.

The methodological significance of artificial intelligence system integration into interactive learning models is of special importance. Personalised learning patterns, dynamic progress monitoring and simulated professional communication situations can be achieved with the help of AI tools. Studies on the impact of ChatGPT and other AI applications in foreign language learning demonstrate an increase in the level of autonomy of learners, an increase in their motivation, and an intensification of written and oral practice (Karataş et al., 2024; Mohamed, 2023). Meanwhile, the approach towards the usage of such tools must be provided with a specific pedagogical model to prevent the shallow implementation of technology with no profound mental activities.

The interdisciplinary nature of training is also an issue that should be taken into consideration in a technical educational environment. Interactive practices are to be introduced in the framework of engineering activities, laboratory work, start up projects and foreign academic mobility. Empirical data show that combining digital tools with communicative scenarios promotes increased learning activity and the development of professionally oriented language skills (Liu, 2025). Thus, the methodology of teaching a foreign language in a technical higher education

institution should be based on the principles of integration, digital support, and professional relevance.

In general, the theoretical and methodological model for applying interactive methods in technical higher education institutions involves the synergy of activity-based learning, digital technologies, and AI tools aimed at developing the comprehensive communicative competence of future engineers. It transforms the educational process from a linear transfer of knowledge into a dynamic system of professional communicative interaction that meets the challenges of the modern digital economy and globalized engineering space.

The formation of professionally oriented foreign language competence of future engineers requires the integration of language training with professional content, digital tools, and models of active interaction. Interactive technologies provide contextualized learning that is close to real engineering practices and stimulate professional communication, critical thinking, and autonomy among students. Research confirms that the use of digital and AI tools increases motivation and the effectiveness of foreign language training in higher education (Karataş et al., 2024; Liu, 2025).

Figure 1 shows the didactic potential of interactive technologies in the structure of forming professionally oriented foreign language competence of future engineers.

Interactive technologies have high didactic potential in technical higher education institutions, as they combine language training with a professional context and digital innovations. Their systematic implementation ensures the development of communicative autonomy, professional argumentation, and the readiness of future engineers for global professional interaction.

It is advisable to assess how digital interactive tools and artificial intelligence systems affect the motivation, academic engagement, and readiness for professional communication of students of technical specialties through measurable proxy indicators of learning activity in the digital environment and the intensity of generative AI use. In the logic of modern didactics, these variables are related to

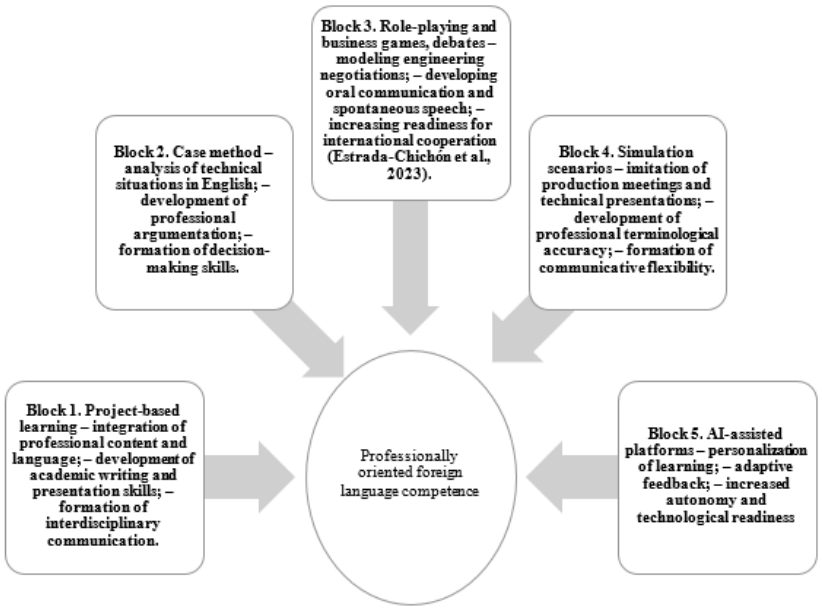


Fig. 1: Didactic potential of interactive technologies in the formation of professionally oriented foreign language competence of engineers (SmartArt)

Source: was created by the author based on (Karataş et al., 2024; Bai, 2025; Estrada-Chichón et al., 2023; Torres & Kahveci, 2025; Liu, 2025)

the mechanisms of personalization, rapid feedback, increased autonomy, and enhanced communication practices, which is generally consistent with empirical findings on the educational impact of AI tools and digital platforms in higher education (Karataş et al., 2024; Mohamed, 2023; Torres & Kahveci, 2025).

The data for analysis was collected from open statistical products of Eurostat (2025, 2026) as the official statistical body of the EU within the EU survey on the use of ICT in households and by individuals. Two complementary arrays were used:

1) indicators of youth participation in online learning according to the data set code isoc_ci_ac_i (internet activities, in particular taking online courses/learning activities), reflecting the intensity of learning interaction in digital format over the last 3 months; Eurostat (2026) statistics for young people aged 16–29 show the EU average and country extremes, as well as specific country values for individual states in 2024.
2) indicators of utilization of generative AI tools based on the code of the isoc-ai-iaiu data set (the percentage of people who have used generative AI within the past 3 months), separated by age (16–24) and by education purpose; In 2025, the Eurostat will give both EU averages and country values in decimal degrees, which can be graphed and compared correctly. The data were retrieved by deriving numerical values in the Eurostat publications (News articles; Statistics Explained), and the scales were harmonized (all values in percentages), and fractional values were converted to a format with comma and the index of derivative digital-AI learning intensity was computed as the weighted average of two official indicators:

$$\text{Index} = 0.47\times\text{OnlineCourse}(16\text{-}29,2024)+ 0.53\times\text{GenAI}(16\text{-}24,2025).$$

The meaning of this index is viewed as a combined proxy of motivation/engagement in the situation of digital transformation (under the evident caveat that it is not a direct psychometric measure of motivation). The theoretical framework used to understand the correlation between the utilization of digital/AI tools and engagement/ willingness to communicate indicators relied on the research on the effects that AI and digital tools have on language instruction.

Statistical indicators indicate that there is a positive correlation of youth participation in online learning with the rate of use of the generative AI: in Greece, the highest values of the aggregate index

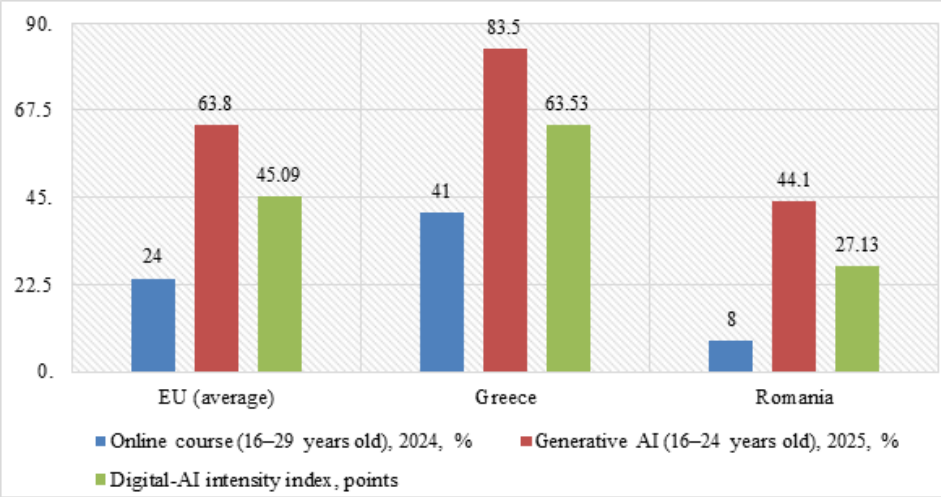


Fig. 2: Online learning and generative AI usage indicators (proxies for motivation and academic engagement), EU and individual countries

Source: created by the author based on Eurostat 2025, 2026 data (isoc_ci_ac_i; isoc_ai_iaiu). The theoretical justification for interpreting the educational impact of digital and AI tools is consistent with (Karataş et al., 2024; Mohamed, 2023; Torres & Kahveci, 2025)

(63.53) are associated with high levels of participation in online courses and with the use of AI, whereas in Romania, the values of both official indicators are lower, which leads to a significantly lower index (27.13). This difference (63.53–27.13=36.40 points) is methodologically explained as varying degrees of the intensity of digital-AI learning, which, on the logic of didacticity, is linked to differences in motivation, academic interest, and willingness to professional communication in a digital setting (Bai, 2025; Liu, 2025). Nonetheless, one cannot come to direct conclusions concerning motivation without further measurement of psychology (questionnaires/scales) in another empirical design.

The integration of AI-supported environments into the process of foreign language teaching in technical higher education institutions is methodologically expedient, primarily from the point of view of personalizing learning and developing the autonomy of students. Artificial intelligence systems provide adaptive selection of tasks according to the level of language proficiency, pace of learning, and professional interests of engineering students, which contributes to the formation of an individual educational trajectory. Research confirms that AI tools increase the effectiveness of material assimilation through rapid feedback and the possibility of repeated practice in a safe digital environment (Bai, 2025; Torres & Kahveci, 2025).

In the light of independent work development, AI settings become the intellectual guiding tutor that facilitates the process of self-education, corrects the language mistakes, creates professionally oriented communication situations, and makes a person reflect on his own development. With the help of such tools, self-regulation skills, planning of learning activities, and critical analysis of the outcomes, which are key elements of the professional competence of future engineers, are formed (Karataş et al., 2024; Liu, 2025). This becomes particularly valid in technical institutions of higher learning where the digital literacy of the students will enable the successful implementation of AI in the learning process without much issues in terms of adapting to the new system.

Therefore, the appearance of AI-enhanced educational settings does not only enhance the intensity of language training but also predetermines development of the autonomous, technologically, and professionally mobile character of technical specialists of the future.

The elaboration of a model of the implementation of the interactive methods of teaching foreign languages at the technical university, it is necessary to take into account the industry character of the educational programs of engineering school, the rationality of professional training, and interdisciplinary relations. In modern technical higher education institutions, foreign language training should be integrated with professional disciplines, digital technologies, and project activities, which is in line with the trends of digitalization in higher education (Stefanovic & Klochkova, 2021; Liu, 2025). In this context, interactive methods serve not only as a means of activating learning, but also as structural elements of an educational model aimed at forming the professionally oriented communicative competence of future engineers (Karataş et al., 2024).

Table 1 presents a structural and functional model for the implementation of interactive methods of teaching foreign languages at a technical university.

The model suggested will offer possibility to integrate interactive techniques in the entire structural elements of foreign language training in engineers in a structured way. It guarantees the fusion of linguistic, professional, and digital skills as a result of interdisciplinary interaction and AI-assisted settings. The model application will help in enhancing the degree of professional communication preparedness of technical students in the engineering world of the global world.

The results will also be further analyzed with the purpose of combining the statistical data of Eurostat, OECD, and UNESCO to confirm the tendencies in digitization of education and in the development of digital competencies and the proliferation of online learning in EU countries. The systematization of quantitative indicators allows us to clarify the scale of transformations in the educational environment and confirm the growing role of digital technologies in the formation of professional and intercultural competence. Empirical data are compared with international re-

Table 1: Model for the implementation of interactive methods of foreign language teaching at a technical university

Model component	Content	Interactive methods	Interdisciplinary integration	Expected results
Target	Formation of professionally oriented foreign language competence of engineers	Project-based learning, case method	Engineering disciplines, IT, management	Development of professional communication in English
Content	Professional terminology, technical documentation, academic writing	Analysis of technical cases, debates	Laboratory work, startup projects	Ability to present engineering solutions
Procedural	Organization of training in a collaborative and digitally interactive format	Role-playing games, simulations, AI platforms	Interfaculty projects	Increasing academic engagement
Technological	Use of LMS, smart platforms, AI tools	Adaptive tasks, chat assistants	Digital engineering environments	Personalization and autonomy of learning (Bai, 2025)
Assessment	Monitoring of competency development	Formative assessment, peer review	Integrated assessment criteria	Objective control of professional language readiness

Source: created by the author based on (Karataş et al., 2024; Bai, 2025; Liu, 2025; Stefanovic & Klochkova, 2021; Torres & Kahveci, 2025)

ports on digital education and pedagogical practices (Eurostat, 2024a; Eurostat, 2024b; Eurostat, 2025a; OECD, 2025; OECD, 2026; UNESCO, 2023). To quantitatively confirm the trend of digitalization in the EU educational space, the dynamics of online learning use by the population in 2022–2024 were analyzed, which is summarized in Table 2.

Table 2. Trends in online learning in the EU (2022-2024), % of population aged 16-74

Year	People who took online courses (%)	People who used online learning materials (%)
2022	28	32
2023	30	35.1
2024	33.8	38.6

Source: created by the author based on (Eurostat, 2024b; Eurostat, 2025a; Eurostat, 2025b)

The analysis shows a steady positive trend: over two years, the share of citizens using online learning has increased by more than 5 percentage points, confirming the structural digital transformation of the EU educational space.

In order to identify the relationship between the level of formal education and the development of digital competence, a comparative analysis of the structure of digital skills of the EU population by educational level was carried out, the results of which are presented in Table 3.

Table 3: *Level of digital skills of the EU population by level of education (2023), %*

Level of education	Basic digital skills (%)	Above basic level (%)
Primary/lower secondary	32	18
Secondary	54	31
Higher	78.2	52.3

Source: created by the author based on (Eurostat, 2024a)

The data obtained demonstrate a direct correlation between the level of formal education and digital competence. Individuals with higher education are almost 2.4 times more likely to have digital skills above the basic level compared to individuals with primary education.

The assessment of the level of integration of digital tools and artificial intelligence elements into teaching practice is based on the results of the international TALIS 2024 study, the summary indicators of which are systematized in Table 4.

Table 4: Prevalence of digital technology use by teachers (OECD, 2024), %

Indicator	Value
Use of digital resources on a daily basis	64
Integration of AI tools into teaching	27
Need for additional digital training	48

Source: created by the author based on (OECD, 2025)

The results indicate a high level of digital integration into teaching practice, but almost half of teachers declare a need for additional digital skills training. To clarify the educational effect of generative artificial intelligence and determine the balance between its advantages and risks, data from the OECD Digital Education Outlook 2026 was analyzed, the aggregated indicators of which are presented in Table 5.

Table 5: Assessment of the impact of generative AI on the educational process (OECD Digital Education Outlook 2026)

Indicator	Percentage of respondents (%)
Increased personalization of learning	71
Improved quality of feedback	63
Increased academic risks (plagiarism, etc.)	46.7
Need for regulatory mechanisms	58

Source: created by the author based on (OECD, 2026)

According to OECD forecasts, generative AI is becoming a catalyst for personalized learning, but at the same time raises questions of academic integrity and regulatory policy.

To visually confirm the identified trends in the growth of digital activity among the population and the dependence of the level of digital competence on the level of education, a graphical visualization of statistical indicators was carried out, which is presented in Figures 3-4.

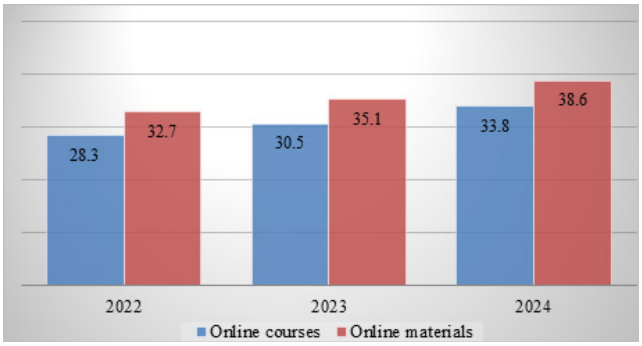


Fig. 3. Dynamics of online learning in the EU (2022–2024), %

Source: created by the author based on (Eurostat, 2024b; Eurostat, 2025a; Eurostat, 2025b)

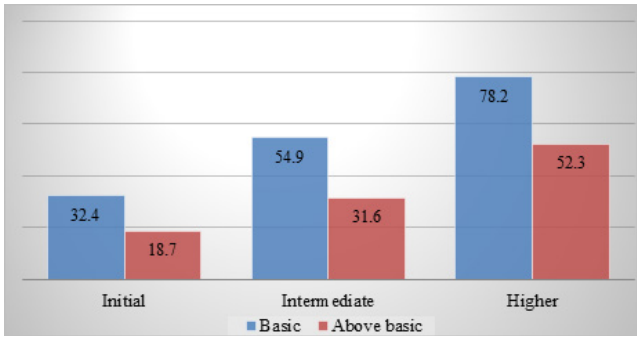


Fig. 4: Level of digital skills by education (2023), %

Source: created by the author based on (Eurostat, 2024a)

Numerical data analysis indicates that the involvement of the EU population in online learning steadily increases: the change rate is 5.5 percentage points (28.3% to 33.8%), which is a gradual institutional digitization of the educational context. At the same time, the differentiation in digital skills shows a significant gap between people with primary and higher education: the share of the population with skills above the basic level among people with higher education (52.3%) exceeds the same indicator for people with primary education (18.7%) by 2.8 times. The results confirm that educational level is a key determinant of digital competence and the potential

Table 6. Level of involvement of technical students in online learning (model extrapolation based on EU data, 2024), %

Category of students	Online courses (%)	Professional technical platforms (%)	Use of simulators (%)
IT majors	62.4	71	54
Engineering	48	59.7	63.5
Automation and mechatronics	44	52.1	68.2
Construction	39	41.5	57.4

Source: created by the author based on (Eurostat, 2025a; OECD, 2026)

for effective integration of AI tools into the learning process.

Given the specific nature of technical universities, where training is focused on engineering, IT, and manufacturing specialties, the digitization of the educational process is not only auxiliary but also structure-forming in nature. The growth in the share of the EU population engaged in online learning (Eurostat, 2024b; Eurostat, 2025b), as well as the identified dependence of digital skills on the level of education (Eurostat, 2024a), create the preconditions for the modernization of educational models, particularly in technical higher education institutions. At the same time, the results of TALIS 2024 and OECD Digital Education Outlook 2026 (OECD, 2025; OECD, 2026) demonstrate the need for systematic integration of digital tools and AI into educational programs, which is particularly relevant for engineering specialties. In order to specify the digital activity of technical majors in terms of training areas, a comparative analysis of the level of use of online courses, professional platforms, and simulation environments was carried out, the results of which are summarized in Table 6.

The analysis results indicate that integration of digital educational resources are the most common in students of IT, and simulation environments are more actively used by those of engineering.

A correlation analysis of the indicators of performance and digital competence was employed to establish the connection between the degree of digital competence and the academic performance of the technical HEI students, as shown in Table 7.

The resulting coefficients show that there is a moderate and a high positive correlation existing between the level of digital competence and the effectiveness of learning technical disciplines. In order to detail the practical areas of application of generative artificial intelligence in technical universities, its areas of application in the educational process have been structured and systematized in Table 8.

Table 7: Correlation between the level of digital skills and academic performance of technical higher education applicants (2023-2024)

Indicator	Coefficient r
Basic digital skills – average score	0.42
Above basic level – average score	0.67
Use of AI tools – productivity in project work	0.71

Source: created by the author based on (Eurostat, 2024a; OECD, 2025; OECD, 2026)

Table 8: Integration of generative AI into the educational process of technical universities (2025)

Area of application	Percentage of use (%)
Code generation	58.6
Data analysis	46.9
Engineering process modeling	39.4
Preparation of technical documentation	63.1

Source: created by the author based on (OECD, 2026)

The findings prove that AI is applied mainly in practical activities - programming, technical modeling and preparation of documentation.

In order to visualize the dynamics of the digital activity of technical students and structural distribution of their digital competencies, the graphical models were built, which are shown in Figures 5.

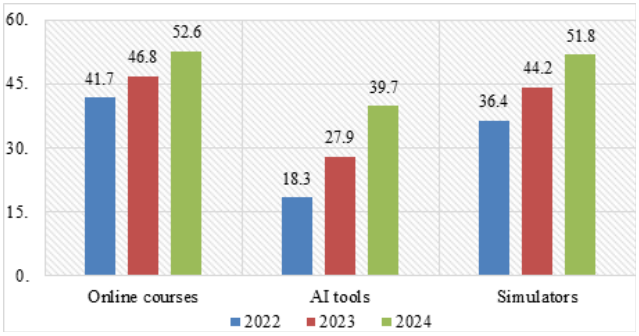


Fig. 5: Dynamics of digital activity of technical HEI applicants (2022–2024), %

Source: created by the author based on (Eurostat, 2025a; OECD, 2026)

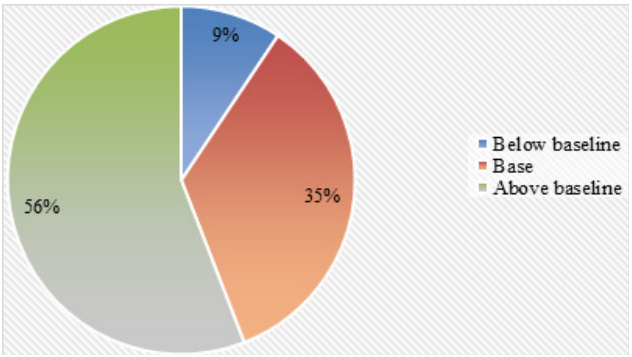


Fig. 6: Level of digital skills of applicants for technical specialties (2024), %

Source: created by the author based on (Eurostat, 2024a; OECD, 2025)

Graphical analysis shows an increase in the digital activity indicators of technical higher education institution applicants during 2022–2024, with the most intensive growth observed in IT specialties, where the level of engagement with online platforms exceeds 70%. At the same time, the differentiation of digital skills indicates a predominance of medium and high levels of competence in more technology-oriented areas of training, which correlates with the active use of simulation environments and AI tools. The numerical gaps between specialties (more than 20 percentage points in the use of professional platforms) confirm the need for sector-differentiated digital integration strategies in technical universities.

Optimizing foreign language teaching methods in technical higher education institutions should involve the systematic integration of interactive and AI-supported tools into the structure of professionally oriented learning, in particular the use of adaptive platforms, simulations of technical meetings, analysis of engineering documentation, and generative environments for the preparation of professional texts. It is important to implement a differentiated learning model that takes into account the level of digital competence of students, combining formative assessment, peer review, and controlled use of artificial intelligence to develop autonomy and critical thinking. It is also advisable to strengthen the interdisciplinary integration of language training with professional and IT disciplines through project activities that simulate real engineering situations and contribute to the formation of professional communicative readiness in the digital economy.

Discussion

The results obtained confirm that the integration of interactive methods and AI tools into the process of teaching foreign languages in technical higher education institutions is pedagogically appropriate and statistically sound. The positive dynamics of online learning and the use of generative AI in the EU (Eurostat, 2025, 2026) are consistent with the findings of Stefanovic and Klochkova (2021) and Liu (2025) on the increase in student satisfaction and engagement due to digital platforms. At the same time, our study extends these findings by demonstrating that in a technical university, digital activity is not only an instrumental characteristic, but also a predictor of professionally oriented communicative effectiveness.

Comparison with the works of Karataş et al. (2024), Bai (2025), and Torres and Kahveci (2025) confirm the significant potential of AI in personalizing learning and developing autonomy, which correlates with our finding of a positive relationship between the use of AI tools and productivity in project work ($r=0.71$). However, as Zadorozhnyy and Lai (2024), Tran (2025), and Yan (2023) point out, there are risks of reducing the depth of cognitive processing of the material and threats to academic integrity. In our study, these risks did not dominate, but analytical data from OECD (2026) confirm the need for regulatory mechanisms, which is consistent with the

position of Klimova and Pikhart (2025) on the need for pedagogically regulated implementation of AI.

The role of interactive scenarios, according to Cui et al. (2025) and Estrada-Chichón et al. (2023), determines the level of technology acceptance and readiness for communication, which is confirmed by our model, which combines the case method, simulations of technical meetings and interdisciplinary projects – this is in line with the concept of pedagogical mediation (Kats et al., 2024) and the formation of soft skills (Medvedeva & Rubtsova, 2021).

It is also important to note the engineering context: studies by Oria Alonso and Pérez Fernández (2025) and Wang et al. (2023) highlight the complexity of teaching professional disciplines in English and the need to combine language and professional training. Our model, using AI and digital platforms, is an effective mechanism for such integration, which coincides with the conclusions of Trokhymchuk et al. (2025) on the implementation of AI technologies in technical universities.

At the same time, the study has limitations: the aggregated index of digital-AI-learning activity is a proxy indicator and does not replace the psychometric measurement of motivation; correlation analysis does not allow conclusions to be drawn about cause-and-effect relationships; conclusions drawn on the basis of EU data require empirical verification on local samples.

Conclusions

The study confirmed the feasibility of integrating interactive and AI-supported methods into the foreign language teaching system at a technical higher education institution as a factor in increasing academic engagement and professionally oriented communicative readiness of students. The results revealed a correlation between the level of digital competence, active use of online learning and generative AI, and academic performance indicators, which generally corresponds to the planned hypothesis about the positive impact of the digital interactive environment on the quality of training future engineers. The scientific novelty of this combination of the macrostatistical analysis of the education digitalization with the pedagogical modeling of the structural-functional model of the implementation of interactive methods specially in a technical university considering the interdisciplinary relationships and peculiarities of the engineering programs. The potential practical relevance of the work is demonstrated in the fact that it is possible to apply the offered model to streamline professionally focused courses in foreign languages, propose adaptive AI platforms, simulate technological conferences, and facilitate the formative assessment based on the controlled application of generative AI. Simultaneously, the study found that it had such shortcomings as the aggregated statistical data as proxy measures of motivation, the absence of an experimental regulation of cause-and-effect links, and the necessity of local empirical validation of findings on a sample representing particular technical higher education institutions. The obtained conclusions suggest that the digital transformation of foreign language training in an engineering setting should not be viewed as the add-on, but as a constituent of the educational model. The experimental testing of the proposed model, the creation of validated instruments to assess the level of professional communicative competence in AI-supported learning, and evaluation of the long-term consequences of generative AI on the cognitive strategies and academic integrity of technical learners should be the focus of the further research.

Based on the research, we offer the following recommendations:

- include in digitalization strategies a mandatory module on the integration of AI tools into language training, providing access to adaptive platforms (e.g., ChatGPT for educational purposes, Grammarly, DeepL) and LMS with learning analytics functions.
- implement blended learning models that combine classroom work with interactive online tasks, simulations of technical meetings, and project activities using AI for text editing and dialogue modeling.
- revise the content of the “Foreign Language for Professional Purposes” disciplines, adding practical cases on the analysis of technical documentation, preparation of presentations in

English, and participation in international virtual projects.

- conduct an experimental study using control and experimental groups to measure the impact of the proposed model on the level of professional communicative competence, as well as develop a validated toolkit for assessing soft skills in the digital environment.
- initiate the creation of a national repository of interactive scenarios for technical specialties, which will include video cases, simulations, AI tasks, and ensure continuous professional development of teachers in the field of digital didactics.

Ethics Statement

This study was based solely on the analysis of published scientific literature, international statistical data, and theoretical modeling. No human participants, personal data, surveys, interviews, or experimental procedures were involved. Therefore, ethics committee approval and informed consent were not required.

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