



Формирование креативной межкультурной коммуникации будущих инженеров при обучении иностранному языку, используя искусственный интеллект

Е. В. ВОЛОДИНА, И. В. ВОЛОДИНА

АННОТАЦИЯ

Проблема и цель. В условиях стремительного развития науки и технологий важную роль играет креативная межкультурная коммуникация между специалистами из различных стран, что обуславливает модернизацию языкового образования.

Цель исследования – разработать и апробировать модель формирования креативной межкультурной коммуникации в техническом вузе при обучении иностранному языку с использованием нового содержания обучения, активных методов и искусственного интеллекта (ИИ).

Материалы и методы. В исследовании приняли участие 102 студента (уровень – бакалавриат) Московского политехнического университета (РФ): в опросе – 52 студента, в эксперименте – 50 студентов. Обучение с использованием разработанной модели проводилось у студентов экспериментальной группы (ЭГ) – 25 человек, у студентов контрольной группы (КГ) – 25 человек нововведения не использовались. Обработка результатов эксперимента произведена с применением анализа произвольных таблиц сопряженности с использованием критерия χ^2 Пирсона.

Результаты. В разработанной модели формирования креативной межкультурной коммуникации у студентов технического вуза ИИ интегрируется в структуру языковой деятельности; познание переходит к «расширенному метапознанию» – осознанному управлению когнитивными процессами в системе «человек – ИИ», что способствует формированию метацифровой компетентности. Внедрение модели в учебный процесс показало статически значимые различия академической успеваемости студентов ЭГ и КГ ($\chi^2 = 39,895$; $p < 0,001$). В результате эксперимента показатели академической успеваемости у студентов ЭГ выше чем у студентов КГ.

Заключение. Внедрение модели формирования креативной межкультурной коммуникации у студентов технического вуза в учебный процесс способствует повышению качества обучения. Использование ИИ в обучении иностранному языку педагогически оправдано на современном этапе. ИИ встраивается в структуру языковой деятельности, не подменяя мышление, а делая его предметом анализа (текстов, дискуссий, формулирования идей и др.) и способствует формированию креативной межкультурной коммуникации у будущих специалистов для межкультурного взаимодействия в современном мире.

КЛЮЧЕВЫЕ СЛОВА

креативная межкультурная коммуникация, искусственный интеллект, языковое образование, метацифровая компетентность, метапознание

Для цитирования: Володина Е. В., Володина И. В. Формирование креативной межкультурной коммуникации будущих инженеров при обучении иностранному языку, используя искусственный интеллект // Перспективы науки и образования. 2026. № 5. С. 190–209. <https://doi.org/10.32744/pse.2026.5.12>

Поступила: 22.04.2025 | Одобрена: 14.07.2026 | Опубликовано: 31.10.2026



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Forming Creative Intercultural Communication of Future Engineers in Foreign Language Teaching Using Artificial Intelligence

E. V. VOLODINA, I. V. VOLODINA

ABSTRACT

Problem and purpose. In the context of rapid scientific and technological development, creative intercultural communication between specialists from different countries plays a crucial role, which necessitates modernization of language education.

The purpose of this study is to develop and test a model of forming creative intercultural communication among technical university students in foreign language teaching using new educational content, active methods, and Artificial Intelligence (AI).

Materials and methods. The study involved 102 bachelor students of Moscow Polytechnic University (Russia): 52 students participated in a survey, and 50 students took part in an experiment. The training using the model developed was conducted in the experimental group (EG) of 25 students, while the control group (CG) of 25 students was taught without the innovations. The experimental results were processed using the analysis of arbitrary contingency tables and Pearson χ^2 criterion.

Results. In the developed model of forming creative intercultural communication among technical university students, AI is integrated into the structure of language activity; cognition transforms into "extended metacognition" – conscious management of cognitive processes within the "human-AI" system, which contributes to the formation of meta-digital competence. The implementation of the model in the educational process showed statistically significant differences in the academic performance of students in the EG and CG (Table 9), which is confirmed by Pearson's $\chi^2 = 39.895$ ($p < 0.001$). As a result of the experiment, the level of academic performance of EG students was higher than CG students.

Conclusion. The implementation of the model of forming creative intercultural communication among technical university students into the educational process contributes to improving the quality of education. The use of AI in foreign language teaching is pedagogically justified at present. AI is integrated into the structure of language activity without replacing thinking, but making it an object of analysis (texts, discussions, formulation of ideas, etc.) and promotes formation of creative intercultural communication among future specialists for intercultural interaction in the modern world.

KEYWORDS

creative intercultural communication, artificial intelligence, language education, meta-digital competence, metacognition

For Citation: Volodina, E. V., & Volodina, I. V. (2026). Forming Creative Intercultural Communication of Future Engineers in Foreign Language Teaching Using Artificial Intelligence. *Perspektivy nauki i obrazovaniya = Perspectives of Science and Education*, (5), 190–209. <https://doi.org/10.32744/pse.2026.5.12>

Received: 22 April 2026 | Approved: 14 July 2026 | Published: 31 October 2026



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INTRODUCTION

Currently, the integration of Artificial Intelligence (AI) into all spheres of life is highly relevant. It requires a transformation of the education system. According to UNESCO, two-thirds of higher education institutions are already implementing or developing guidelines for the use of AI in teaching and learning [1]. The need to develop advanced digital skills (Digital Skills, DS) and to integrate educational technologies and AI into higher education is highlighted in analytical reports by the OECD (2025) [2], OECD (2025) [3].

By 2030, Russia plans to implement AI products in all areas of activity, including the educational sector. Russian AI technologies must be globally competitive and possess the highest possible level of sovereignty. In accordance with the Decree of the President of the Russian Federation of May 12, 2023 No. 343 Russia is implementing a pilot project to introduce a new model of higher education. The project aims to test an updated structure of professional education and establish a national system that meets modern requirements.

Key goals and advantages:

1. Flexibility and alignment with the labor market. The system allows for more precise adjustment of duration and content study to the real needs of the economy. Basic education provides a profession, while specialized education is pursued only if an additional qualification is required.
2. Elimination of duplication. The new model bridges the gap between a bachelor's and a specialist's degree, making the education structure more logical and transparent.
3. Focus on priority sectors. The pilot project emphasizes engineering, technical, natural sciences, and pedagogical specialties – the very fields where Russia needs qualified personnel.
4. Transparency of qualifications. For each level, the duration of study and qualification a graduate will obtain are clearly defined.

Thus, the new model makes the higher education system more adaptive, consistent, and result-oriented, which should enhance the competitiveness of Russian specialists [4].

The role of the modern university in the economy and society is determined by the challenges of the Fourth Industrial Revolution, whose key concepts are global digital transformation, the digital economy, Big Data, AI, and advanced manufacturing technologies. It is also shaped by a new format of interaction among scientific, educational institutions and business, characterized by scientific-educational and entrepreneurial activities. In this model, education is built on the results of cutting-edge scientific research, while entrepreneurial activity should lead to the formation of an innovation ecosystem around the university [5].

The use of digital technologies in education plays a key role in developing digital competencies. V. Basilotta-Gómez-Pablos et al. note that digital competence enables the use of information and communication technologies (ICT) in various spheres of life, including the professional field [6]. M. Abdillah and M. Wahyulahi share their point of view [7].

In the context of the escalated geopolitical situation, ensuring a policy of technological sovereignty is of particular importance. O. Sudorgin and E. Makarenko note that this doctrine, essentially a continuation of import substitution, began to be actively promoted in our country in the second decade of the 21st century [8]. It involves production of domestic analogues to replace foreign components. Innovation is the foundation of the economy, and scientific research is the foundation of innovation. The integration of Artificial Intelligence technologies into pedagogical methods is taking place. The role of creative intercultural communication in professional sphere including innovative engineering, scientific, and research activities for modern specialists is increasing.

Theoretical and methodological basis of this study comprises the papers on the use of generative Artificial Intelligence (Gen AI), neural network technologies, machine learning systems, and active methods for teaching English at university. It is essential to consider not only opportunities but also risks associated with their use. Z. Bakirova et al. consider that a pedagogical model utilizing these technologies enhances digital competence, which, in turn, increases motivation, self-efficacy,

engagement, and academic performance [9]. K. Shvab, presents a wide range of features of the modern digital era. He offers to use a systematic approach to their analysis, emphasizing that «Technology and society mutually shape each other. We are a product of our technologies to the same extent that they are a product we create» [10].

Active use of digital platforms contributes to higher learning outcomes in an AI-enabled environment, while engagement mediates the relationship between access to digital resources and academic achievement. Digital transformation is shaping the future of science, innovation, and society worldwide. This is an era of rapid change driven by the development of the Internet, mobile devices, big data, AI and other technologies.

In the digital age, new methods related to online platforms, mobile applications, AI, and virtual reality (VR) are used for teaching foreign languages. AI refers to technologies that enable machines to perform tasks requiring human intelligence. This includes data analysis, pattern recognition, natural language text processing and query handling, learning from data streams, and decision-making. F. Ouyang, L. Zheng, P. Jiao identified the effectiveness of AI in adaptive learning and personalization of the educational process: differentiated approach, personalized education, independent work, continuous monitoring and assessment of each student's progress [11].

To meet modern requirements, a future specialist besides mastering the necessary core of professional knowledge should also possess creative imagination, be able to manage it, learn to think systematically, overcome mental inertia, identify and resolve technical contradictions, generate non-standard ideas, have skills in multivariant problem-solving and their objective evaluation, possess creative intercultural communication skills for intercultural interaction. Students also must develop cognitive abilities.

The UNICEF concept outlines skills for forming creative innovations. Creativity is a part of the 4C structure of soft skills as one of the key characteristics of 21st-century education and upbringing [12]. E. Torrance equates creativity with creative thinking, considers that it is primarily related to the problem-solving process including the following components:

- searching for, identifying, and formulating a problem;
- generating hypotheses regarding problem-solving methods;
- sensitivity to problematic situations;
- testing these hypotheses;
- finding and formulating solutions;
- interpreting and popularizing results [13].

J. Guilford identifies six parameters of creativity:

- ability to detect and define problems;
- ability to generate a large number of problems;
- semantic spontaneous flexibility – ability to produce diverse ideas;
- originality – ability to produce distant associations, unusual responses, non-standard solutions;
- ability to improve an object by adding details;
- ability to solve non-standard problems by demonstrating semantic flexibility, i.e., to see new features in an object and find new uses for them [14].

The research conducted by Martin Prosperity Institute on creativity rankings concludes that the 3T model (technology, talent, tolerance) can only be viable when combined with individual creativity [15]. Federal Institute for Education Quality Assessment conducted a literacy assessment in 2023 based on the PISA model (an international education quality research model) and designated Russia's weighted average rank as 9.625, indicating attention from the education system to developing elements of creativity [16].

W. Holmes, M. Bialik and C. Fadel note that the use of AI is essential for enhancing skills in the study of foreign languages, particularly in writing, grammar, and vocabulary [17]. X. Chen et al. consider that it requires the development of AI literacy among educators for effective pedagogical and cognitive development purposes [18].

R. Watkins and E. Barak-Medina think that students use the didactic potential of digital technologies to develop personal qualities such as communication skills, time and stress management, speed reading, creativity, and the ability to innovate [19].

J. Momrian observes that the formation of students' phonetic speech skills is improved through the use of AI-based applications [20]. A. Widyana, M. Jerusalem, B. Yumechas highlight that Text-to-Speech (TTS) – a technology that converts text into speech that offers a wide selection of languages and voices [21]. This tool allows teachers to create unique materials for developing students' listening skills. The research shows that applying this technology in English classes increases students' interest in learning and positively affects pronunciation skill development. A positive impact is also noted in reading skill development: improvement in students' reading fluency and better understanding what they read. E. Volodina and I. Volodina note the effectiveness of using simulators as well as students' interest in using them [22].

S. Muammar, K. F. B. Hashim, A. Panthakkan show that cognitively engaged students use more complex learning strategies and develop critical thinking, which positively affects their test results [23]. Individual cognitive abilities and creative intercultural communication are interconnected. Cognitive abilities influence the success of intercultural interaction, while creativity in communication is linked to the ability to generate new ideas and change unproductive ones. The connection between cognitive abilities and creative intercultural communication depends on individual differences – how open people are to new experience, how they adapt to a new culture, and how actively they engage in comparing cultures. Context also affects how strong this connection will be.

G. Sabanal et al., consider that motivation and academic performance are positively related [24]. In the context of language study using AI in professional fields, including innovative engineering and scientific research activity motivation is fundamental as it influences students' initiative in language acquisition, their persistence in overcoming difficulties, and their overall success in forming creative intercultural communication for intercultural interaction. W. Bin-Hady et al. assume that chatbots facilitate interactive practice by increasing student motivation and engagement [25].

R. Ryan and E. Deci distinguish intrinsic (internal) and extrinsic (external) motivation [26]. To achieve sustainable success, a combination of both external and internal factors is necessary. External motivation refers to factors outside an individual that influence behavior, such as rewards, grades, or external pressure, for example, social expectations or economic incentives. External motivation plays an important role in the educational process for students. Internal motivation includes factors that originate within an individual, such as personal goals, interests, and values. Internal motivation is closely linked to integrative motivation, which reflects a positive attitude and strong personal interest in the culture and people associated with the language being studied [27]. Integrative motivation encourages learners to deeply engage with the language, culture, and community associated with the language being studied, thereby enhancing their learning experience and language proficiency.

S. Torre, A. Severino, M. Ligorio consider that for the purpose to achieve a high level of student satisfaction, it is essential to consider the diversity of their needs, preferences, and expectations. This requires flexibility in approaches to organizing the educational process, as well as the creation of a comfortable and supportive learning environment [28].

A. Membrive et al. emphasize the importance of developing individualized learning trajectories, which are formed on two interconnected levels: the level of engagement and continuity of experience across various contexts and activities, and the level of subjective learning experiences associated with this engagement [29].

The concept of metacognition and the interrelation between metacognition and affective processes in learning is examined in the research of M. Konkol, E. Maryina [30]. They reveal the methodological foundations and systemic architecture of meta-digital competence (MDC) as a theoretical basis for the development of professional competencies of educators in the context of

AI spread. The research is based on a systemic analysis of theoretical foundations of meta-digital competence with the integration of principles of cognitive psychology, distributed cognition theory, and the competency-based approach.

The term metacognition was introduced by J. Flavell, who defined it as the ability to analyze one's own thinking strategies and manage one's cognitive activity. This term also denotes a special form of education in which a student does not merely memorize dry facts and figures but develops holistically as a person throughout the entire educational process [31].

In modern psychology and neuroscience, metacognition is interpreted as a person's ability to be aware of, monitor, and regulate their own cognitive processes. It is not simply "thinking about thinking," but a complex system that includes:

- metacognitive knowledge – understanding one's own mental abilities, strategies, strengths, and weaknesses;
- metacognitive experience – subjective experiences during problem-solving (e. g., feelings of confidence or doubt);
- metacognitive regulation – the ability to plan, monitor, and evaluate the course and outcome of one's mental activity [32].

In the era of generative AI, it is transforming into the concept of "extended metacognition" – the ability to consciously manage distributed cognitive processes within the "human + AI" system. These studies allow us to conceptualize human-machine interaction as an extension of the cognitive system.

The system of meta-digital competence (MDC) differs qualitatively from traditional digital competence in key functional parameters. The difference between digital and meta-digital competence is that digital competence focuses on specific skills and abilities, while meta-digital competence focuses on integrative aspects of working with digital technologies. Meta-digital competence (MDC) is an integrative ability of an individual for effective, conscious and ethically responsible interaction with digital technologies, particularly AI.

Some features of MDC:

- six-component structure – cognitive, reflexive, practical, ethical, social, and adaptive components;
- consideration of the specifics of human-machine partnership in education, for example, in the context of integrating AI into the educational process;
- integrative approach – MDC offers an integrative approach, which ensures competitiveness in the context of labor market transformation and educational standards.

English language teachers use AI-based tools.

Considering that the relevance and prospects for integrating generative neural networks into education are enormous, and their application can increase learning efficiency, make the process of preparing materials faster and more convenient, as well as open new opportunities for creativity and interdisciplinary projects in engineering education when teaching a foreign language, we propose the following study hypothesis: the formation of creative intercultural communication among technical university students in the process of language training will be most effective if the learning process is based on a model of forming creative intercultural communication among technical university students, with innovations defined (goals, content, methods, tools, and forms of teaching using AI, taking into account social risks and responsibility).

Object of the study: the educational process of training students in the discipline "Foreign Language" (English for Special/Specific Purpose) for students at a technical university.

Purpose of the study: to develop and test a model of forming creative intercultural communication among technical university students in the English language teaching (English for Special/Specific Purpose) using innovations.

Study objectives: to conduct an analysis of philosophical, linguodidactic, psychological-pedagogical literature, research, and the state of this problem at the university, and to determine relevance, shortcomings, and ways to solve them.

MATERIALS AND METHODS

The study involved 102 second and third year students of Moscow Polytechnic University, Transportation Faculty (level of education «baccalaureate») – 52 students participated in the survey, and 50 students took part in the experiment. The average age – 18 – 20 years. Among participants: 58 – boys and 44 – girls.

The pedagogical experiment was conducted in two stages. During the first stage (2018–2021), an analysis of scientific literature was carried out, pedagogical experience was summarized, and innovations in the content and methods of teaching were developed. In the second stage (2022–2025), trial teaching, questionnaires, testing, and the experiment itself were conducted, followed by a statistical analysis of the results using contingency tables and the Pearson's χ^2 criterion (<https://medstatistic.ru/calculators/calchit.html>). Student testing data in the control and experimental groups is presented before and after the experiment.

Survey results

At Moscow Polytechnic University, an anonymous survey was conducted among 52 second- and third-year students on the use of AI in learning English (Table 1).

Table 1 Questionnaire on the use of AI in learning English

No	Question	Answer
1	Would you like to learn how to use AI tools for studying foreign languages? (yes, no)	
2	Do you use AI tools? (yes, no)	
3	If you use AI in your studies or work, what exactly do you use it for? For example: searching and analyzing information, grammar checking, text generation, pronunciation practice, etc.	
4	Which AI services/tools do you use? ChatGPT, DeepSeek, DeepL, Google Translate, Duolingo, ELSA Speak, Praktika.AI, etc.	
5	How do you evaluate the effectiveness of AI in learning English? You may use a scale (e.g., from 1 to 5 points).	
6	What do you consider to be the main negative aspect of using AI in learning? For example: "digital dependency", factual or logical errors in answers, lack of emotional contact and motivation.	

As a result of an anonymous survey, the following data was obtained:

1. The survey was conducted among students with the purpose of identifying the demand for and experience of using AI tools in learning the English language.
2. Frequency of AI usage. 45 respondents note that they use AI technologies in their studies. Out of these, 20 people use AI daily, 25 — several times a week, and 7 people — rarely or only in extreme cases.
3. Popular tools. The most popular services include: neural network translators (DeepL, Google Translate), vocabulary training apps (Duolingo, Quizlet), and generative models (ChatGPT) for explaining grammar and writing texts.
4. Purpose of using AI in language learning: searching and analyzing information, grammar and spelling checking, text translation, speaking practice, and creating personalized exercises.
5. Attitude towards AI usage. The majority of students (45 people) have a positive attitude towards the use of AI, noting the convenience of access to materials, personalization of tasks, and operational feedback.

6. Difficulties and limitations. The main difficulties noted include problems with translation accuracy, not always taking into account the context or nuances of the language, and the risk of decreased motivation with excessive dependence on technology.

7. Conclusions. The survey results confirm that AI has become an integral part of students' independent work. Now the main role of AI is automation of routine tasks, but students are aware of its limitations. The vast majority believe that AI cannot completely replace a teacher, as it lacks the capacity for empathy and a deep understanding of the context of live communication.

STUDY RESULTS

Innovations in Learning Content

The innovations in the content of the «Foreign Language» discipline (ESP) include topics on innovative engineering and research activities aimed at forming readiness for creative intercultural communication. The lexical material of these topics contains a terminological base for professional and scientific communication in the field of innovation and research activities. The content of the innovations reflects methods for managing the development of innovation process in a competitive environment, as well as methods for developing and making non-standard, creative decisions in the technical innovation market. The material is presented accessibly – with theory supported by practical assignments.

Development of cognitive abilities

To deepen knowledge and develop skills and cognitive abilities including creative abilities, creative and critical thinking we use the rules for applying the heuristic questions method and a system of questions (see Table 2).

Rules for applying the heuristic questions method

1. Memorize the most characteristic heuristic questions and, if possible, systematize them.
2. Ask yourself questions that would:
 - a) simplify the task;
 - b) allow you to understand the task from a new, unexpected perspective;
 - c) stimulate the use of acquired knowledge and experience from solving other tasks;
 - d) allow you to break the task down into subtasks;
 - e) encourage self-control.

The system of heuristic questions that stimulate knowledge acquisition and develop skills and creativity among students is shown in Table 2.

Table 2 System of heuristic questions

Types of skills questions	Didactic objectives
What is the main idea? What is the essence ? What, where, when, what ? Give the definition ... Formulate the theorem ...	Deepening and expansion of knowledge

Describe ... Retell ... Explain ... How to use ? What is the difference ? Give the examples ... Summarize ... Systematize ... Classify ...	Development of skills
How to solve in another way ? What are the reasons ? Do you agree with this statement ? Give counter-evidences ... What are the disadvantages ? What is your prognosis? Find the mistakes ...	Development of creative abilities and critical thinking

We use a question classifier and a list (operations of thinking, forms of thinking, functions of discursive thinking: induction, deduction). The classifier contains questions for analysis, questions for specification (generalization), questions for forecasting, project questions (questions for synthesizing information), questions for identifying the essence, and questions for substantiating a position (see Table 3). The classifier of reproductive and productive questions is provided in Table 3.

Table 3 Classifier

REPRODUCTIVE QUESTIONS	1. What events are described in the article? 2. What is called ? 3. Name the main participants of these events. 4. Name the stages of the event. 5. Name the actions of the participants.
PRODUCTIVE QUESTIONS	I. Questions for analysis 1. What are the reasons? 2. What are the consequences? II. Questions for concretization 1. What are the results? 2. Give the overall assessment. III. Questions for forecasting What will happen if...? IV. Project questions (questions for synthesis of information) 1. What should one have done if the problem had not been so complicated? 2. What are the ways of solving this problem? V. Questions for identification of essence 1. What is the basis? 2. What is the meaning of the situation? 3. What is the main idea? VI. Questions for justification of position 1. Why do you think that...? 2. What can you prove with...? 3. Give the arguments proving... 4. Prove of your position...

The use of these questions forms thinking operations: comparison, analysis, synthesis, abstraction, concretization; forms of thinking: judgment, concept, inference; functions of discursive thinking: induction, deduction (Table 4).

Table 4 List operations, forms and functions of thinking

OPERATIONS	DEFINITION of CONCEPT
1. Operations of thinking	
Comparison	Comparison of objects and phenomena in order to find similarities or differences between them
Analysis	Dismemberment of the integral structure of an object
Synthesis	Reunification of elements into a holistic structure
Abstraction	Identification of the common features of an object, their separation from isolated, random, and shallow ones
Concretization	An operation opposite to abstracting generalization, i. e. a return to understanding of the object in the fullness of its individual specificity
2. Forms of thinking	
Judgment	A form of thinking that reflects connections and relationships between entities
Concept	A thought that reflects the most general, essential, and distinctive features of objects and phenomena in reality
Conclusion	A form of thinking that represents a sequence of judgments in which, as a result of the establishment of relationships between them, a new judgment emerges, distinctive from the previous ones
3. Functions of discursive thinking	
Induction	The movement of thought in the process of reasoning from specific judgments to a general conclusion
Deduction	The final judgment is the result of the movement of thought from general positions to particular judgments

The interconnection of science, education, and production is currently a priority. Figure 1 shows a structural-functional scheme of innovation system in the technical innovation market, illustrating creation, implementation, and operation of technical innovations under market competition.

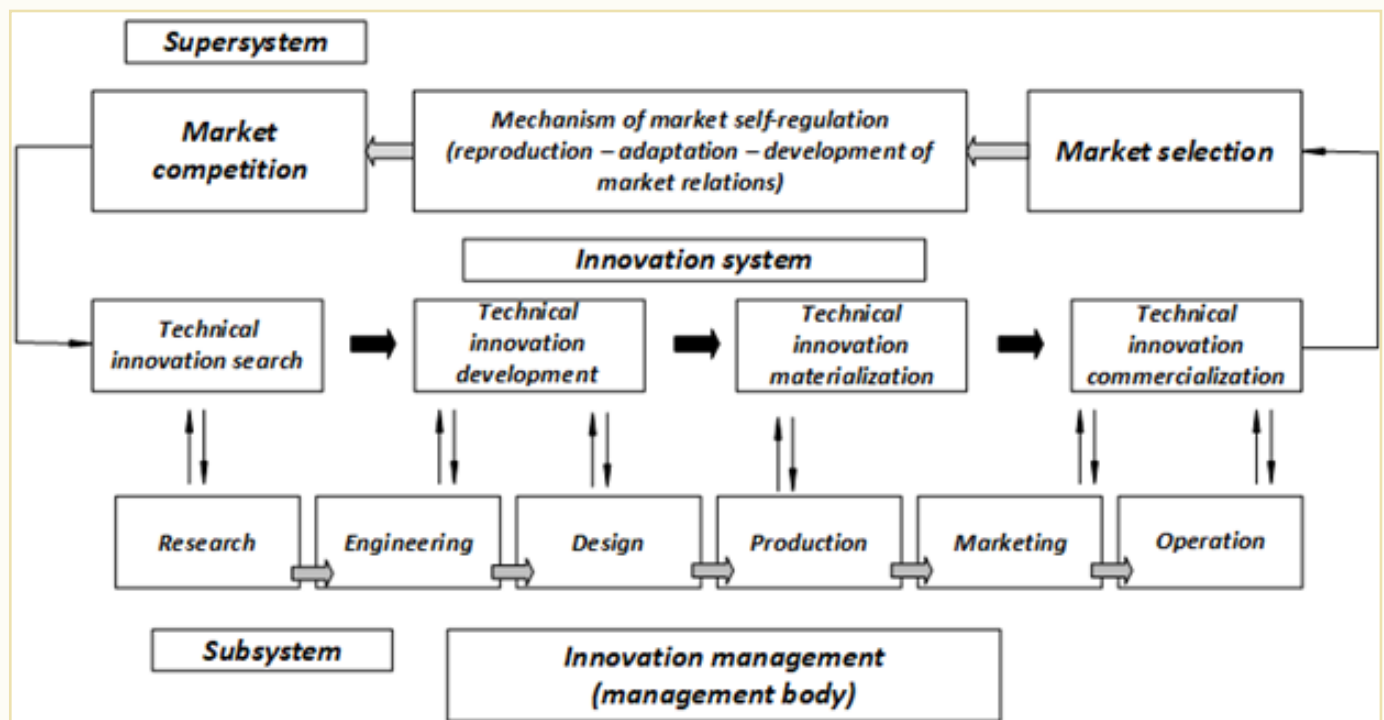


Figure 1 Structural and functional scheme of innovation system in conditions of technical innovation market

The functions of all elements of the innovative system are directed towards generation (search, development), communication (dissemination, diffusion), transformation (development, conversion), and direct implementation (operation) of technical innovations. The development and implementation of innovations were carried out taking into account the provisions of this systemic approach.

The stages of scientific research and their results are shown in Figure 2.

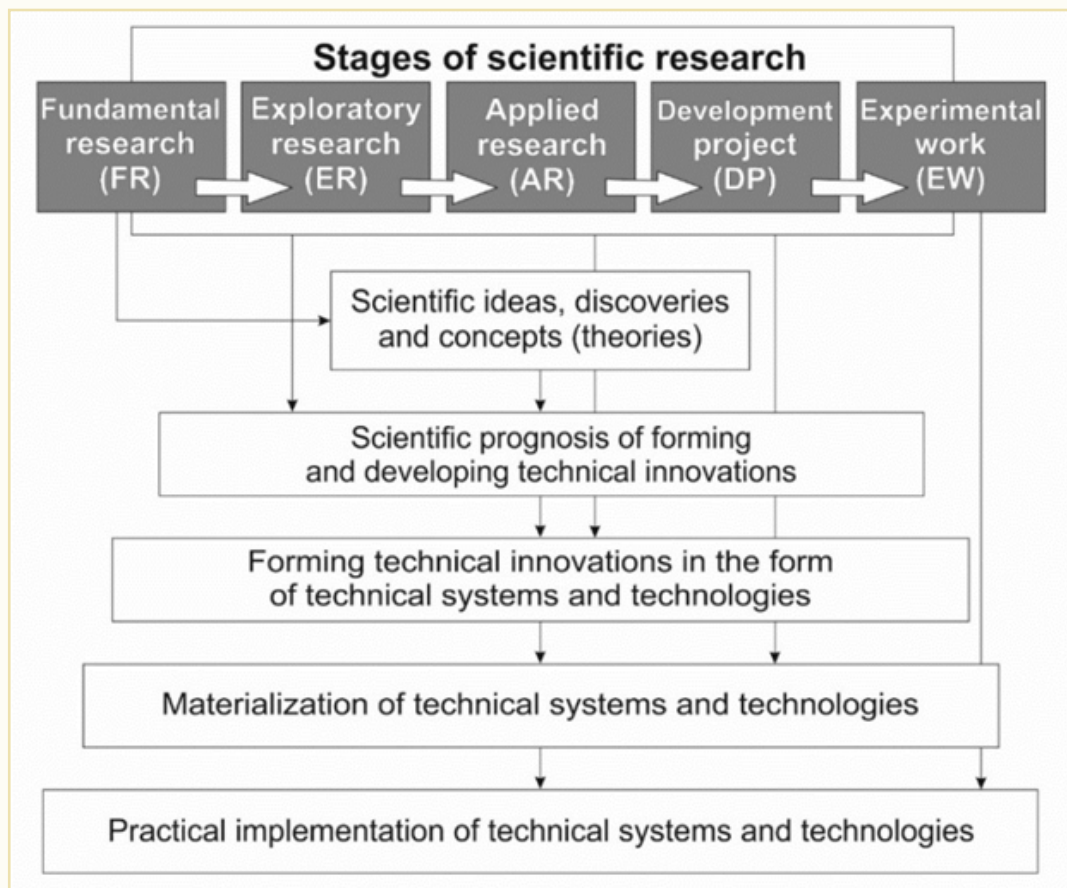


Figure 2 Stages of scientific search

Thus, students got familiar with stages of research and their results and used this information in their project activities. The characteristics of the pedagogical system are shown in Table 5.

Table 5 Creative pedagogical system

CHARACTERISTICS	PEDAGOGICAL SYSTEM
Learning purpose	Practical, general education, developmental, strategic (global), conscious acquisition of fundamental knowledge - core of information and targeted development of cognitive skills: creative and critical thinking, creative intercultural communication Practical, general education, developmental, strategic (global), conscious acquisition of fundamental knowledge - core of information and targeted development of cognitive skills: creative and critical thinking, creative intercultural communication
Nature of pedagogical process	Creative development of a person, his/her professionally significant qualities, and emotional sphere of a person
Educational aspect	Strong moral and strong-willed qualities: will, broad outlook, confidence in one's creative abilities, activity, desire for self-improvement, self-expression, self-control, tolerance, healthy lifestyle, love for people and profession
Learning content	Focus on the future, innovation and research activities, development of mental abilities, increase of creative potential, use of active learning methods, digital technologies and artificial intelligence

Scheme of cognitive activity	Scheme of search cognitive activity
Study of the personality of a student, study group	Study of psychological characteristics of students' personalities, interpersonal communication style and study group team
Management of students' cognitive activity	Flexible. Leadership style is democratic – collaboration, co-creation
Methodological materials for students	MOODLE LMS Platform; Textbooks, teaching aids, and AI (Artificial Intelligence) tools: - language learning apps; - text generation programs; - chatbots; - automated assessment; - speech recognition software; - text-to-speech transformation tools; - data analysis and learning tools; - virtual and augmented reality technologies.
Result of students' educational activities	Formation of creative intercultural competence
Border control	Testing the ability to operate knowledge
Final assessment (exam)	Possession of competencies according to the Work Program

The implementation of basic didactic principles is carried out through active teaching methods and methods for stimulating creativity via lesson structure, original content, the application of digital technologies and AI, and classes on the MOODLE LMS platform with electronic resources for various fields of study and in-person instruction. The structure of a lesson in the creative pedagogical system is defined, including the experimental application of AI elements in the educational process (Fig. 3).



Figure 3 Structure of a class in the creative pedagogical system

Block 1 (motivation) – a system of techniques that can cause surprise, develop curiosity and interest in a discipline.

Blocks 2 and 6 (content) contain a course curriculum. The use of innovations, including digital technologies and AI, facilitates development of students' cognitive skills: creative and critical thinking (development of memory, including the stages of memorization, storage, consolidation, and retrieval – recognition and reproduction of the information received and decrease of forgetting), creative intercultural communication, and higher academic performance. So, future specialists will be able to interact successfully with representatives of other cultures to solve professional problems.

Block 3. (psychological relief) – is implemented through exercises to harmonize the development of the cerebral hemispheres.

Block 4. (puzzle) – development of creative imagination and fantasy using the following methods: control questions, phraseological units method, snowball method, goldfish method, etc.

Block 5 (intellectual warm-up) – a series of increasingly challenging tasks designed to stimulate the mind, improve brain function, and develop motivation. In this block, the students were asked to do puzzles and quizzes, which allowed them to develop their creativity and logical thinking.

6. Intellectual warm-up is a system of challenging tasks aimed at developing motivation, thinking and creative abilities of students.

7. Active learning methods, digital technologies and AI – intellectual support that provides motivation and development of cognitive abilities among students, contributing to the formation of creative intercultural communication.

8. Feedback. Assessment of completed tasks on MOODLE LMS platform and during face-to-face lessons.

In the second stage of the experiment (2022–2025) a model of forming creative intercultural communication among technical university students was developed (Fig. 4).

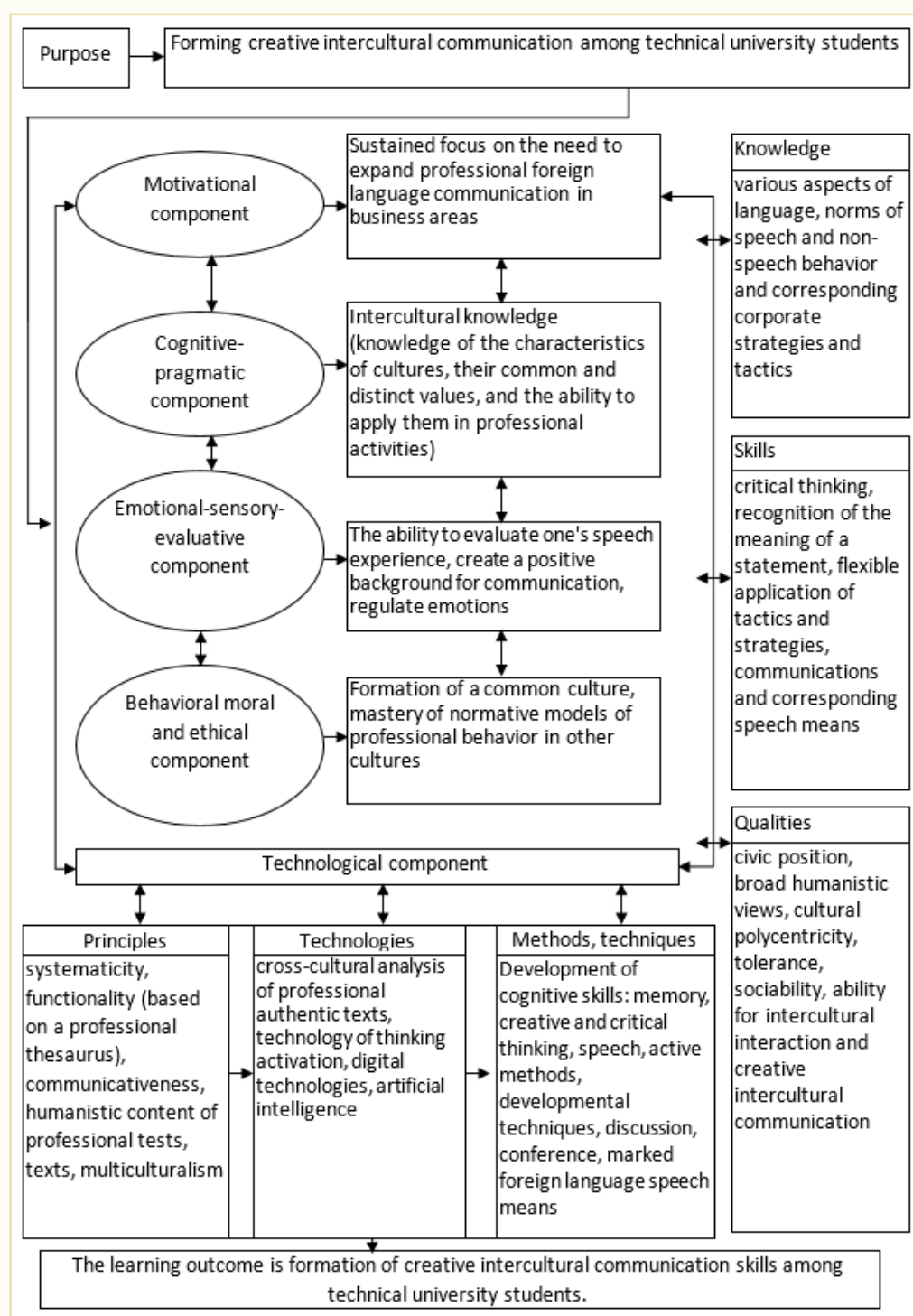


Figure 4 Model of forming creative intercultural communication among technical university students

The study conducted is based on the concept of the unity of language, thinking and culture, as well as competency-based, communicative, and linguo-sociocultural approaches, and modern scientific views on the structure of communication. Currently, the purpose of teaching a foreign language at a technical university is not only the formation of competencies, knowledge, and skills among students and their academic performance, but also the formation of meta-digital competence, cognitive properties, and creative intercultural communication in both oral and written forms, ability to perceive intercultural development of society within socio-historical, ethical, and philosophical contexts and engage in intercultural interaction.

At Moscow Polytechnic University, electronic educational resources for the «Foreign Language» discipline were developed and made available for all fields of study on MOODLE LMS platform. The university's educational process utilizes blended learning: a combination of face-to-face and distant on Moodle LMS.

The ability of students to undergo professional training remotely from the university using advanced information technologies is an advantage that makes education accessible to a wide range of individuals.

English language teachers use the following AI-based tools:

- virtual and augmented reality technologies;
- language learning applications;
- text-to-speech and speech recognition software;
- text generation programs;
- chatbots;
- data analysis and learning tools;
- automated assessment of work.

EXPERIMENT RESULTS

In the experiment conducted, a model of forming creative intercultural communication among technical university students was tested (Figure 4). The experiment involved 50 participants: 25 in the experimental group (EG) and 25 in the control group (CG). Training in the EG was conducted using innovations: active teaching methods, digital technologies, and AI, while the CG was taught without these innovations.

Descriptors for assessing creative intercultural communication are given in Table 6.

Table 6 Results of the experiment

No	Levels of preparation for creative intercultural communication among students	Descriptors for assessing creative intercultural communication
1	Cognitive descriptors	Thinking flexibility Ability to synthesize diverse ideas Depth of cultural reflection Ability to identify hidden cultural patterns Cross-cultural empathy
2	Communicative descriptors	Adaptability of verbal communication Competence in non-verbal communication Ability to overcome creatively language barriers Active listening skills considering cultural specifics Ability to conduct dialogue in conditions of high cultural distance
3	Behavioral descriptors	Readiness for experimentation Openness to borrowing Ability to work in multicultural teams Creative resolution of intercultural conflicts Initiative in creating cross-cultural projects

4	Productive descriptors	Novelty of the product/idea Practical applicability Cultural relevance Scale of impact Sustainability of results
5	Emotional and personal descriptors	Tolerance for ambiguity Curiosity Emotional stability Motivation for intercultural interaction Sense of humor considering cultural differences

To assess the level of creative intercultural communication, a point-rating system was used (see Table 7).

Table 7 Point-rating system

Points	Mark	Grade
85 – 100	5	excellent – high level
71 – 84	4	good – average level
55 – 70	3	satisfactory – low level
0 – 54	2	unsatisfactory

The experiment revealed that the innovations implemented into the educational process had a positive effect: students who used the innovations developed motivation, cognitive abilities, creative and critical thinking, meta-digital competence, and achieved a higher level of academic performance.

Student testing data

The experimental results were processed using the analysis of contingency tables with the use of Pearson's χ^2 criterion (<https://medstatistic.ru/calculators/calchit.html>). The input diagnostics of students' knowledge levels based on testing results in the control and experimental groups is presented in Table 8.

Table 8 Input diagnostics of students' knowledge levels in the control and experimental groups based on testing results

Factorial variable	Output variable				Sum
	5	4	3	2	
EG	19	5	1	0	25
CG	13	9	1	2	25
Total	32	14	2	2	50

The number of degrees of freedom is 3.

The value of the χ^2 criterion is 4.268.

The critical value of χ^2 at a significance level of $p < 0.05$ is 7.815.

The relationship between the factor and the resulting features is statistically insignificant; the level of significance is $p > 0.05$.

The significance level is $p = 0.234$.

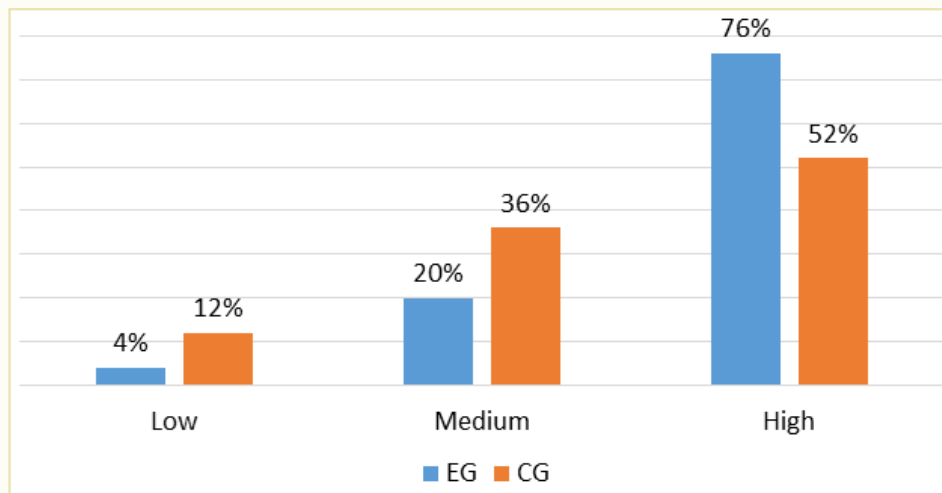


Figure 5 Start of the experiment

Table 9 Students' testing results in the control and experimental groups after the experiment

Factorial variable	Output variable				Sum
	5	4	3	2	
EG	22	3	0	0	25
CG	0	16	9	2	25
Total	22	19	9	2	50

The number of degrees of freedom is 2.

The value of the χ^2 criterion is 39.895.

The critical value of χ^2 at a significance level of $p = 0.01$ is 9.21.

The relationship between the factor and the resulting features is statistically significant at a significance level of $p < 0.01$.

The significance level is $p < 0.001$.

The study results indicate that the innovations we proposed and the means of their implementation are effective, and the experimental results are reliable.

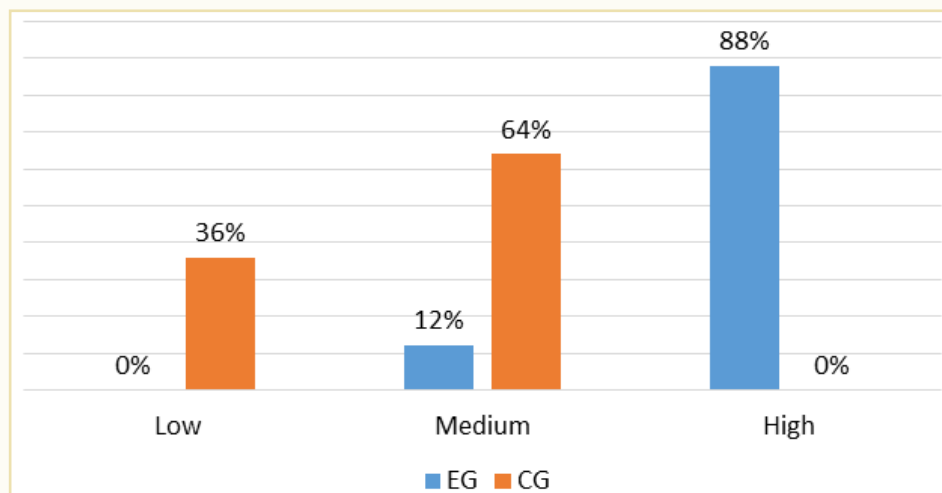


Figure 6 End of the experiment

Testing shows that students in the experimental group, where teaching was conducted using innovations, demonstrate a higher level of metadigital competence and academic performance, as well as superior cognitive abilities and creative intercultural communication, compared to the control group, where teaching was carried out without the use of innovations.

The use of innovations contributes to the development of students' cognitive abilities, including creative and critical thinking (development of memory, encompassing the stages of memorization, storage, consolidation, and retrieval – recognition and reproduction of information received and reduction of forgetting), metadigital competence, creative intercultural communication, and higher academic performance. The results of the experiment were confirmed.

DISCUSSION

The relevance of the study conducted by the authors is driven by the necessity to prepare engineering students to establish technological and scientific sovereignty in the country. One of the key conditions for forming and strengthening our country's technological sovereignty is high-quality training of engineers. We agree with the authors' assertion that technological sovereignty is based on the principle of displacing imported equipment through domestic manufacturers and involves the production of domestic analogues to replace foreign components [8]. Artificial Intelligence technologies can rightfully be considered at the forefront of scientific and engineering thought.

A contemporary trend is the formation of meta-digital competence. M. Konkol, E. Maryina describe meta-digital competence (MDC) as a theoretical foundation for the development of professional competencies of educators in the context of AI use [30]. This is a correct assertion. Together, these theoretical approaches create a methodological platform for conceptualizing human-machine interaction as an extended cognitive system.

In modern understanding, metacognition is often structured into three main components:

- metacognitive knowledge (reflective knowledge about cognitive and personal determinants of cognition).
- metacognitive experience (emotional and subjective aspects of cognition).
- metacognitive regulation (active control and regulation of the cognitive process).

We agree with Flavell's assertion that if traditional cognition is defined as "the ability to reflect, understand, and control one's own learning," then in the era of generative AI, it transforms into the concept of "extended metacognition" – the ability to consciously manage distributed cognitive processes within the "human + AI" system [31].

N. Guskova and A. Erakstova, based on sociological survey data, note the extremely high adaptability of the youth to the digitalization of society and the absence of psychological barriers when using new information technologies [33]. And this is indeed the case: students show great interest, engagement, and motivation for using AI.

The statements of V.M. Alpatov are of interest: he believes that the future lies in the study of the "black box," that is, what is inside the human brain [34]. However, when introducing AI into the educational process, it is also necessary to consider its drawbacks. We agree with this statement. The task of universities at the present stage is to train technical specialists capable of responding to new technological challenges (the ability to create technological and scientific sovereignty in the country through the application of innovative technologies and AI).

CONCLUSION

In connection with Russia's transition to an innovative development path, pedagogical science faces the task of training a new generation of professionals capable of ensuring the country's technological and scientific sovereignty. This is linked to the modernization of language education in Russia. Foreign language education is aimed at the intellectual, cultural and professional development of an individual.

In the context of the rapid proliferation of generative Artificial Intelligence, a key task for higher education in foreign language teaching is to utilize AI as a new technological opportunity (additional resource) without losing autonomy, depth, and subjectivity of foreign language education.

The scientific novelty of the study lies in the following:

1. Innovations were developed for «Foreign Language» discipline for professionally-oriented English language training of students at technical universities. The purpose is to form readiness for professional communication in English in the sphere of engineering, innovative, and scientific-research activities. The professional activity of future specialists will be connected with innovative activities, including the development, implementation, and commercialization of innovations (products, processes, and services).
2. A scientifically based approach to the formation of creative intercultural communication was developed. This approach is based on the concept of the unity of language, thinking and culture in the context of applying AI. It takes into account that cognition is being transformed into the concept of "extended metacognition" – the ability to consciously manage distributed cognitive processes in the "human + AI" system and the necessity of forming meta-digital competence, as well as knowing the limitations of using AI.
3. A model of forming creative intercultural communication among technical university students in professional activity, including innovative engineering and scientific-research activities was developed.

Theoretical significance of the study lies in expanding modern ideas about activating formation of creative intercultural communication for intercultural interaction among technical university students in the professional sphere, including innovative engineering and scientific and research activities. Terminology for this activity was included and examined from the perspective of:

- cognitive aspect: the mechanisms by which phenomena are conceptualized in the language, as well as the acquisition, processing, storage, and retrieval of information;
- communicative aspect: the mechanisms of interaction between participants in discourse, and strategies for managing communicative flow;
- culturally-conditioned aspect: the background of knowledge, attitudes, and values; avoidance of potential conflict zones; and the cultural-linguistic picture of the world, which allows discourse participants to adequately interpret a partner's message and construct their own considering the addressee's consciousness model.

During our study, theoretical aspects of forming students' cognitive abilities were developed, including:

- creative and critical thinking;
- memory development including the phases of memorization, storage, consolidation, and retrieval
- recognition and reproduction of information received and reduction of forgetting;
- thinking, attention, perception, language and speech.

The issues related to developing an optimal educational model, identifying pedagogical conditions and creating educational resources aimed at the effective development of students' creative intercultural communication at technical universities are of particular relevance. This is in accordance with the modern requirements of the state in the field of the quality of professional education, as well as growing needs of an individual, society and employers.

Practical significance of the study lies in the development of scientifically based innovations for students of different study fields. Their future professional activities will be connected with innovative processes, development, implementation, and commercialization of innovations (products, processes, and services).

As a result of implementing a set of innovations in the educational process for teaching a foreign language (English), the problem of training technical specialists possessing professional competencies necessary for 21st-century specialists to create technological and scientific sovereignty in the country is becoming relevant. Taking into account modern trends provides an opportunity for continuous

development of education by actualizing content and constantly updating educational materials. The study was conducted for the bachelor's degree level. It is relevant to continue studies for other levels of education: specialist, master, and postgraduate (PhD) programs.

The study has confirmed the need for continuous development of education and updating of content, constantly revising educational materials, introducing new content and teaching technologies, including AI, that contribute to the formation of competitive specialists. This is essential for achieving technological and scientific sovereignty in the country.

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Авторы

Володина Е. В.

(Россия, Москва)

Доцент, кандидат педагогических наук
Московский политехнический университет

E-mail: alina661966@mail.ru

ORCID ID: 0000-0003-1951-336X

Scopus Author ID: 55612230500

Володина И. В.

(Россия, Москва)

Преподаватель

Колледж Hexlet

ORCID ID: 0000-0003-3141-2836

E-mail: elina-volodina@rambler.ru

Scopus Author ID: 57219744315

Author's

Elena V. Volodina

(Russia, Moscow)

Associate Professor, PhD in Pedagogical Sciences
Moscow Polytechnic University

E-mail: alina661966@mail.ru

ORCID ID: 0000-0003-1951-336X

Scopus Author ID: 55612230500

Inga V. Volodina

(Russia, Moscow)

Teacher

Hexlet college

ORCID ID: 0000-0003-3141-2836

E-mail: elina-volodina@rambler.ru

Scopus Author ID: 57219744315

Вклад авторов

Володина Е. В.: концептуализация, методология, создание рукописи и ее редактирование, руководство исследованием, администрирование проекта, верификация данных, проведение исследования, написание черновика рукописи, формальный анализ, визуализация

Володина И. В.: программное обеспечение, проведение исследования, ресурсы

Author's contribution

Elena V. Volodina: Conceptualization, Methodology, Writing - Review & Editing, Supervision, Project administration, Validation, Investigation, Writing - Original Draft, Formal analysis, Visualization

Inga V. Volodina: Software, Investigation, Resources

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Авторы заявляют об отсутствии конфликта интересов

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The authors declared no conflicts of interest