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Psychological and Pedagogical Aspects of Student Interaction with Chatbots in the Process of Independent Learning

الجو انب النفسية والتربوية لتفاعل الطلاب مع روبوتات الدردشة في عملية التعلم المستقل

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Abstract: The study aimed to identify the characteristics of psychological and pedagogical interaction between students and chatbots in the process of independent learning, considering cognitive load, motivational factors, personalisation of learning, and the effectiveness of digital feedback. The methodology included content analysis, comparative analysis of educational policies, structural and functional analysis, and theoretical modelling of the chatbots Khanmigo, Woebot, Mondly, and ELSA Speak, which identified the advantages and limitations of each in the context of developing learning autonomy. The study demonstrated that chatbots combined task adaptability with pedagogically sound prompts, instant feedback, and the ability to respond emotionally. For instance, Khanmigo optimised cognitive load by gradually increasing the complexity of the material, Woebot provided psychological support in conditions of anxiety, and ELSA Speak demonstrated a high level of personalisation through the analysis of speech behaviour. An analysis of five key international educational documents identified the regulatory framework within which the state should support the implementation of artificial intelligence (AI) in higher education. The study emphasised the institutional integration of AI tools into the learning environment and the need to develop the digital competencies of teachers. The documents emphasised the significance of ethical use of chatbots and transparency of algorithms and highlighted the role of digital tools in shaping independent thinking, criticality, and value awareness among students. The study determined that combining chatbots with the structured CAMELEON pedagogical model creates an effective environment for independent student activity, reducing overload, increasing interest, and promoting the development of self-regulation. The practical significance of the study is determined

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by the fact that its results can be used by teachers, developers of educational platforms, and administrations of higher education institutions to integrate chatbots into students' independent learning activities, incorporating psychological and pedagogical needs and digital strategies.

Keywords: Self-regulated learning, Digital communication, Emotional engagement, Cognitive activity, Adaptive strategies.

المستخلص: هدفت الدراسة إلى تحديد خصائص التفاعل النفسي والتربوي بين الطلاب وروبوتات الدردشة في عملية التعلم المستقل، مع مراعاة الحمل المعرفي، والعوامل التحفيزية، وتخصيص التعلم، وفعالية التغذية الراجعة الرقمية . شملت المنهجية تحليل المحتوى، والتحليل المقارن للسياسات التعليمية، والتحليل البنيوي والوظيفي، والنمذجة النظرية لروبوتات الدردشة Khanmigo و Woebotو Mondlyو ELSA Speak، مما أتاح تحديد مزايا وقيود كل منها في سياق تنمية الاستقلالية في التعلم. أظهرت الدراسة أن روبوتات الدردشة تجمع بين قابلية تكييف المهام، والإرشادات التربوية المدروسة، والتغذية الراجعة الفورية، والقدرة على الاستجابة العاطفية؛ فعلى سبيل المثال، ساهم Khanmigo في تحسين الحمل المعرفي من خلال زيادة تدريجية في تعقيد المادة، بينما قدم Woebot دعماً نفسياً في حالات القلق، وأظهر ELSA Speak مستوى عالياً من التخصيص من خلال تحليل السلوك الكلامي .كما حدد تحليل خمسة وثائق تعليمية دولية رئيسية الإطار التنظيمي الذي ينبغي أن تدعم من خلاله الدولة تطبيق الذكاء الاصطناعي في التعليم العالي. وأكدت الدراسة على أهمية الدمج المؤسسي لأدوات الذكاء الاصطناعي في البيئة التعليمية، والحاجة إلى تطوير الكفاءات الرقمية لدى المعلمين. كما أبرزت الوثائق أهمية الاستخدام الأخلاقي لروبوتات الدردشة وشفافية الخوارزميات، وسلطت الضوء على دور الأدوات الرقمية في تنمية التفكير المستقل والنقدي والوعي القيمي لدى الطلاب . وخلصت الدراسة إلى أن الجمع بين روبوتات الدردشة والنموذج التربوي المنظم CAMELEON يخلق بيئة فعالة لنشاط الطلاب المستقل، من خلال تقليل الحمل الزائد، وزيادة الاهتمام، وتعزيز تنمية التنظيم الذاتي. وتكمن الأهمية التطبيقية للدراسة في إمكانية استخدام نتائجها من قبل المعلمين ومطوري المنصات التعليمية وإدارات مؤسسات التعليم العالي لدمج روبوتات الدردشة في أنشطة التعلم المستقل للطلاب، مع مراعاة الاحتياجات النفسية والتربوية والاستراتيجيات الرقمية.

الكلمات المفتاحية: التعلم المنظم ذاتياً، التواصل الرقمي، التفاعل العاطفي، النشاط المعرفي، الاستراتيجيات التكيفية.

1 INTRODUCTION

The active use of chatbots in students' independent learning activities has necessitated a psychological and pedagogical perception of new forms of interaction between humans and digital agents that perform educational functions. Changes in traditional learning formats, the growing role of artificial intelligence (AI) in the process of knowledge acquisition, the formation of learning motivation, cognitive activity and self-regulation have created conditions for rethinking pedagogical approaches to the organisation of autonomous student work. Virtual assistants, which provide prompt feedback and personalised support, have become a tool for transforming the educational environment, which at the same time creates risks of fragmented knowledge, reduced critical thinking and interpersonal interaction. The actualisation of this area of research identified effective strategies for implementing digital solutions in the educational process, provides psychological and pedagogical support to students, and improves methodological models for supporting independent activity in the context of the digitalisation of education.

Researchers have studied this topic and shared different views on it. For example, Černý (2023) analysed educational chatbots without the use of AI, emphasising the impact of interface design on the user's psycho-emotional state. The study highlighted the significance of cognitive load minimisation and chatbot response predictability for ensuring comfortable learning interactions. Han (2021) studied the experience of Korean students in learning English with the help of AI chatbots. As a result, an increase in students' confidence in using language structures, a decrease in anxiety levels, and stimulation of language activity outside the classroom were found. The analysis covered the specifics of digital interaction, which contributed to the formation of a positive emotional background during learning. Jeon (2024) analysed the perceptions and experiences of younger students in English as a Foreign Language class when interacting with chatbots. The study found a positive impact on motivation to learn the language, increased student initiative, and the development of independent study skills. The study covered aspects of the effectiveness of user interaction with chatbots depending on the context of use and the academic level of the students. Factors such as personalisation, ease of use, and flexibility of communication scenarios was significant. Kuhail et al. (2023) conducted a systematic review of interactions with educational chatbots, classifying them according to their purpose and functions. The study identified key barriers to use, including low emotional engagement and the lack of adaptive behaviour in chatbots. In their article, Lazarenko and Hapchuk (2024) analysed the role of AI in the transformation of higher education, emphasising the challenges and opportunities in the context of digitalisation. The study highlighted the need to strengthen students' digital competence, expand their autonomy and develop independent learning management skills.

The pedagogical model included four key components, namely context, action, technology, and support, which ensured the seamless integration of the chatbot into the learning environment. The study proved that the use of this approach increased student engagement and contributed to the development of autonomous planning skills for learning activities. Lin and Chang (2023) developed the pedagogical model Cognitive-Humanistic Approach to Teaching Activities for Communicative Training Scenarios to implement active and self-regulated learning through personalised chatbots. The study demonstrated that, by incorporating the individual characteristics of students, chatbots contributed to the formation of a responsible attitude towards the learning process. In their work, Panok et al. (2025) formulated methodological principles for creating chatbots for educational purposes, incorporating psychological safety and adaptability. The study justified the need to use a psychologically comfortable communication style that reduces stress and stimulates learning activity. Ryu (2024) studied students' attitudes towards chatbots in the context of Korean language practice, revealing both a positive perception of technology and difficulties in establishing contact with the bot. The work emphasised the role of feedback, interactivity and system flexibility in maintaining motivation. Tymoshchuk (2024) highlighted the digitalisation of philological education in Ukraine, exploring the potential of chatbots as tools for individual learning. The importance of digital technologies in ensuring the accessibility of education was emphasised, as well as the need for methodological support for the effective implementation of new tools. Yin et al. (2024) analysed the impact of emotions induced during interaction with educational chatbots on student motivation levels. The researchers concluded that positive emotional reinforcement and adaptive behaviour of the chatbot correlated positively with engagement in the learning process.

Although previous studies have examined educational chatbot effectiveness, student motivation, social presence, and language-learning outcomes, these aspects are often analysed separately. Fewer studies integrate cognitive load, emotional engagement, learning autonomy, feedback structure, trust in a digital intermediary, and pedagogical support within a single conceptual framework for independent learning. This creates a gap in understanding how chatbots can function not merely as technological tools, but as psychologically and pedagogically structured agents that support students' self-regulated learning. The novelty of this study lies in the integrated analysis of educational chatbots through psychological and pedagogical criteria, including cognitive load, motivation, social presence, emotional engagement, feedback structure, personalisation, and trust in a digital intermediary. Unlike studies that examine chatbot functionality mainly from a technological or language-learning perspective, this article links chatbot use specifically with the organisation of students' independent learning and the development of self-regulation. An additional contribution is the application of the CAMELEON digitally supported cognitive-social learning model to explain how student-chatbot interaction can be structured as adaptive pedagogical support rather than as isolated digital assistance. The study aimed to substantiate the psychological and pedagogical foundations of student interaction with chatbots in the process of independent learning. To achieve this goal, the following tasks were set: to analyse digital chatbots and the educational, psychological and pedagogical aspects of teaching students in higher education; to review international documents on the implementation of chatbots in student learning; to identify the psychological and pedagogical components of effective interaction in the "student-chatbot" format.

2 MATERIALS AND METHODS

The study used methods such as content analysis of digital products, comparison of educational policies, structural and functional analysis of interfaces, and theoretical modelling. As part of the content analysis, the functional characteristics of chatbots that are actively used in higher education were investigated. In particular, the capabilities of the ChatGPT platform were considered, which provides the generation of personalised responses, support for reflective thinking, and stimulation of independent learning. The Khanmigo chatbot, built on GPT-4, was analysed. It performs the functions of a digital tutor in the process of individual student learning in the fields of Science, Technology, Engineering, and Mathematics (STEM). The Mondly Chatbots programme, which is focused on developing dialogue skills within the framework of independent language practice, was studied. The ELSA Speak AI Tutor bot for developing correct English pronunciation, which adapts to the user's level and provides for daily independent interaction, was also studied. Analysis of Woebot, which provides psychological support in a digital environment based on a cognitive-behavioural approach and demonstrates the potential of AI technologies in creating a sense of social presence, was emphasised. The above chatbots were selected based on their widespread use in higher education, the availability of clearly defined educational functions (cognitive support, language skills development, tutoring interaction, psychological regulation) and compliance with the following criteria: independence of interaction, adaptability, pedagogical orientation, integration into the digital learning environment. In addition, the study analysed the following psychological and pedagogical aspects of student interaction with chatbots: cognitive load, learning motivation, social presence, emotional engagement, personalisation of the learning experience, feedback structure, and trust in the

digital intermediary. In particular, the aspect of cognitive load was considered from the perspective of J. Sweller et al. (2011) theory of limited attention resources, which determined the extent to which the chatbot interface facilitated or hindered effective information assimilation. Learning motivation was assessed through the presence of external and internal stimuli, in particular, elements of gamification, adaptation, and content support. Social presence was analysed in the context of the perception of the chatbot as an interaction participant capable of maintaining dialogue and emotional contact, according to the concept (Garrison et al., 2000).

As part of a comparative analysis of educational policies, the concepts of digital transformation in education presented in documents such as the Digital Education Action Plan (European Commission, 2023), Recommendation on the Ethics of Artificial Intelligence (UNESCO, 2021), Education for the Digital Age (World Bank, 2024), Learning Compass 2030 (Organisation for Economic Co-operation and Development, 2022) and Reference Framework of Competences for Democratic Culture (Council of Europe, 2018). Official international documents published over a ten-year period (2015-2025) that directly addressed the integration of digital technologies and chatbots into education and were available in English or Ukrainian were selected for analysis. Local, non-public or outdated materials without an educational context were excluded. The comparison was made based on parameters such as strategic priorities for the digital transformation of education, the development of digital competences of students and teachers, methodological approaches to personalisation and adaptability of learning, the functional capabilities of chatbots to support self-regulated learning, as well as compliance with ethical standards and data security. The analysis identified common approaches to the integration of chatbots as tools for personalised support, the development of autonomy, critical thinking and democratic competences. These documents identified pedagogical guidelines within which chatbots are being introduced into educational activities. Structural and functional analysis of chatbots identified key interface components that affect the quality of interaction, including adaptability, scenario variability, feedback, cognitive stimulation, and elements of empathic interaction. Theoretical modelling formulated a conceptual scheme of pedagogical interaction in the "student-chatbot" format within the framework of independent activity, incorporating cognitive load, motivational factors, and the dynamics of learning autonomy formation, based on the model of cognitive-social learning with digital support from CAMELEON.

In this study, the CAMELEON model was used as a theoretical framework for explaining how chatbot-based interaction can support independent learning through the integration of cognitive, motivational, emotional, and social components. The model was selected because it corresponds to the logic of digitally supported cognitive-social learning: students do not simply receive automated answers, but interact with a digital agent that can provide adaptive prompts, regulate task complexity, support reflection, and maintain engagement. Its theoretical basis combines cognitive load theory, self-regulated learning, social presence theory, and motivational approaches to learning autonomy. Therefore, the model made it possible to analyse student-chatbot interaction not only as a technological process, but also as a structured psychological and pedagogical mechanism of support.

3 RESULTS

3.1 Analysis of digital chatbots and educational, psychological, and pedagogical aspects of teaching students in higher education

Chatbots integrated into digital educational platforms increase the effectiveness of independent learning by students thanks to their ability to interact automatically, adapt to the individual level of the user, generate meaningful feedback, and support cognitive and metacognitive processes. They promote the development of self-regulation skills, stimulate motivation to learn, provide personalised support, reduce learning stress, and promote autonomy. Depending on their functional orientation, chatbots can act as digital tutors, language partners, assistants in the development of academic literacy, or even means of psychological stabilisation, which ensures their pedagogical value in the context of higher education (World Economic Forum, 2025). In particular, the ChatGPT platform generates personalised responses, supports reflective thinking, and stimulates independent learning. This tool is widely used by students to explain concepts, model situations, create educational content, and plan individual learning paths, making it a versatile assistant in various academic disciplines. The Khanmigo chatbot, built on GPT-4, which functions as a digital tutor in the Khan Academy ecosystem, is analysed. It is used to provide hints, develop effective strategies for solving problems in STEM fields, explain complex concepts, and provide micro-feedback focused on developing critical thinking and self-regulated learning. Such tasks and concepts include solving equations, building mathematical models, analysing physical phenomena, algorithmic cognition, data processing, and mastery of concepts such as Newton's laws, programming principles, or chemical reactions.

The Mondly Chatbots programme is designed to develop conversational skills during individual foreign language practice. Through simulated conversations, adaptation to topics and levels of difficulty, the platform increases students' communication confidence and promotes the acquisition of new vocabulary in an authentic context. In particular, ELSA Speak AI Tutor specialises in developing correct English pronunciation through individual voice exercises. This bot adapts to the speaker’s accent, pace and level, provides daily feedback and trains intonation and phonetic skills (the ability to correctly reproduce intonation patterns, stress, rhythm, and sounds of speech in accordance with its phonetic norms) for students seeking academic or professional mobility. The Woebot chatbot provides digital psychological support using the principles of cognitive behavioural therapy. Its distinctive feature is its ability to recognise the user’s emotional state and adapt its responses to situations of stress, anxiety or demotivation, thereby ensuring conditions for sustainable learning in conditions of psycho-emotional stress. Woebot recognises emotional states by analysing the vocabulary, style of speech and emotional tone of the user's text messages, and then selecting therapeutically relevant responses. Table 1 provides a comparative description of educational chatbots based on criteria of pedagogical effectiveness,

including functionality, adaptability, independence of interaction, pedagogical focus, and integration into the digital learning environment.

Table (1). Comparative characteristics of chatbots according to pedagogical effectiveness criteria

Program name	Functionality	Implementation details	Independence of interaction	Adaptability	Pedagogical orientation (for students)	Integration into the digital learning environment
ChatGPT (OpenAI)	Generation of personalised responses, support for reflective thinking	Accessible via web or API, powered by GPT-4 model	High level of autonomous interaction	High adaptability to style, language, and complexity of requests	Used as an intelligent assistant for preparing for seminars, developing critical thinking, creating notes and presentation plans	Easily integrates with LMS, browsers, and learning modules
Khanmigo (Khan Academy)	Digital tutor, explanation of concepts, asking questions, and feedback	Integrated into Khan Academy, specialisation — STEM disciplines	Designed for individual interaction in an educational environment	Adaptation to the student's level of knowledge, intellectual support	Used for independent study of complex topics in physics, mathematics, and computer science; preparation for tests and exams.	Integrated into the Khan Academy educational platform
Mondly Chatbots	Practice of dialogical speech, simulation of everyday situations	Mobile application, support for over 30 languages, based on scripted dialogues	The student chooses the topic and leads the dialogue.	Limited responses based on predefined scenarios	Use for practising spoken language, expanding vocabulary, and simulating real conversational situations before travelling or interviews.	Partial — in mobile app format

ELSA Speak AI Tutor	Pronunciation training, AI-based feedback, progress assessment	English-oriented, uses voice recognition	Individual language practice via mobile interface	High – adaptation to accent, tempo, user level	Useful for improvement of English pronunciation, preparation for international language tests (TOEFL, IELTS), and daily conversation practice	Integration into personal learning path via mobile application
Woebot	Digital psychological support, mood monitoring, cognitive-behavioural prompts, stress regulation	Mobile application based on cognitive-behavioural techniques and conversational AI	High level of individual interaction in a confidential digital format	Moderate to high – adaptation to the user's emotional tone, stress indicators, and repeated interaction patterns	Useful for reducing learning-related anxiety, supporting emotional stability, encouraging reflection, and maintaining motivation during independent learning	Integrated mainly through mobile use; can complement digital learning environments as a psychological support tool

Source: compiled by the authors.

Table 1 presents a comparative description of educational chatbots, considering their functionality, technical features, and pedagogical potential. However, the effectiveness of their application directly depended on the consideration of psychological and pedagogical aspects. To achieve the expected learning outcomes, it is necessary to ensure purposeful pedagogical interaction, emotional support, motivation for independent activity, and the development of students' cognitive activity when using each of the tools. These aspects include cognitive load, learning motivation, social presence, emotional engagement, personalisation of the learning experience, metacognitive regulation, autonomy in learning, sense of agency, feedback structure, and trust in the digital intermediary. Cognitive load determines how much the chatbot interface helps students to effectively perceive information without overload (Kullolli, 2024; Tamietto et al., 2005). Thanks to the adaptability of tasks and a gradual increase in complexity, the Khanmigo chatbot optimises the load, maintaining a balance between challenge and accessibility of material. In the learning process, this manifests itself in students receiving tasks that correspond to their current level of knowledge, which helps avoid frustration or loss of interest. Mondly Chatbots, on the other hand, limit freedom of choice through rigid dialogue scenarios, which sometimes leads to

additional effort to adapt and increased cognitive load. Students using this bot occasionally encounter difficulties in adapting to fixed dialogues, which may reduce the effectiveness of material assimilation. The psychological and pedagogical aspect of learning motivation is determined by the presence of internal and external incentives for learning (Celeghin et al., 2023). Mondly Chatbots actively uses gamification: points, levels, and rewards motivate students to practise speaking regularly. In the learning process, this is reflected in increased interest among students who want to raise their level or receive additional rewards, which encourages them to work systematically (Astvansh, 2025; Huseynov, 2024). For students seeking further learning, ChatGPT maintains motivation through personalised responses and the ability to receive detailed explanations on various topics. In practical learning, this stimulates intrinsic interest, as students can ask questions based on personal needs and receive explanations that contribute to their mastery. For example, agronomy students use the chatbot to clarify the specifics of crop fertilisation in specific climatic conditions. Future linguists receive explanations of grammatical structures in the context of literary texts, and economics students analyse consumer behaviour models using market examples.

Personalisation of the learning experience can adapt the material to individual needs (Al-Rajab et al., 2022; Ruggieri et al., 2020). In practice, students can receive explanations of specific topics that cause them difficulty or review material to the extent necessary for themselves using ChatGPT. ELSA Speak AI Tutor analyses the specifics of the user's pronunciation and offers personalised exercises to correct speech errors, which significantly increases the effectiveness of learning. Students receive specific recommendations and exercises targeting their weaknesses, which makes the learning process more focused. The structure of feedback affects the quality of learning, as Khanmigo provides clear, pedagogically sound recommendations that help students recognise and correct their mistakes. In the learning process, this can be used for quick correction of mistakes and improves the quality of knowledge. ELSA Speak AI Tutor provides instant voice feedback, which is necessary for effective pronunciation correction. Students receive immediate feedback on their pronunciation, which contributes to faster improvement of language skills. In general, trust in a digital intermediary determines the level of student engagement. Mondly Chatbots builds trust through a specialised approach to language practice, which encourages regular use of the bot in learning. The ChatGPT programme, thanks to its high-quality responses and wide range of functions, promotes engagement, although it requires a critical approach to information, which stimulates the development of analytical skills (critical analysis of information, comparison of alternatives, identification of cause-and-effect relationships, systematisation of data and formation of reasoned conclusions) and independent assessment of the knowledge gained (Coffey, 2025; Kullolli et al., 2026). Thus, each psychological and pedagogical aspect is closely related to certain features of chatbots and their potential in learning. The consideration of these aspects when

implementing tools in the learning process increases the effectiveness of independent learning and motivates students to engage in active cognitive activity.

3.2 Overview of key international documents on the implementation of chatbots in student education

The European Commission (2023) document "Digital Education Action Plan" outlines a strategic vision for the digital transformation of education in the EU for 2021-2027. The central idea of the plan is to create an inclusive, effective and sustainable digital educational environment in which digital technologies, in particular chatbots, are used as personalised support for learning and the development of digital competences. The plan provides for the integration of intelligent digital tools at all levels of education to ensure flexibility and adaptability in the learning process. The section on digital skills emphasises the need to develop digital pedagogy among teachers, including the ability to use chatbots as elements of digital mentoring, means of providing feedback and tools for adaptive assessment.

The document stipulated that the use of AI services must comply with the principles of safety, transparency, and ethics. This requires quality control mechanisms and the prevention of biased treatment of users based on algorithmic decisions. The document highlights the creation of conditions for the widespread use of AI in school and higher education. In particular, it envisages the development of a European Digital Education Hub, which includes digital platforms with integrated chatbots capable of supporting independent student learning. The plan emphasises the importance of cooperation between Member States in developing interoperable education systems, scaling effective digital solutions, including chatbots, to the EU level. It states that states should promote the use of such solutions in line with national strategies for the digitalisation of education. National strategies for the digitalisation of education include the development of digital infrastructure, the improvement of digital competences of those involved in the educational process, the introduction of innovative digital tools and ensuring equal access to quality education.

According to the Digital Education Action Plan, chatbots can contribute to two key goals: supporting inclusive access to learning materials and improving the quality of the learning experience through personalisation and continuous interaction (European Commission, 2023). It also states that AI tools should be integrated into virtual learning environments that support self-regulated learning, developing skills of learning autonomy, self-control and time management. The section on digital education in EU universities focuses on the use of chatbots in microlearning, in particular for developing students' career-oriented skills. The document provides for financial support for projects aimed at implementing chatbots, such as intelligent tutors for STEM majors. At the same time, special attention is paid to data security issues, in particular the need for tools to comply with the General Data Protection Regulation standards.

The Organisation for Economic Co-operation and Development (2022) document "Learning Compass 2030" proposes a comprehensive approach to education aimed at developing key competencies for life in a digital society. The study emphasised the need to develop not only subject knowledge, but also critical thinking, creativity and digital literacy skills. The introduction of chatbots is regarded as an effective means of supporting personalised and adaptive learning, helping students navigate the information space and develop self-regulation skills and metacognitive abilities. This document emphasises the importance of transparency, ethics and data protection in the use of digital tools, emphasising the training of teachers for the quality integration of such technologies into the educational process. In turn, the Reference Framework of Competences for Democratic Culture focuses on developing the competences necessary for active participation in a democratic society (Council of Europe, 2018). The document highlights the values, knowledge, skills and attitudes that shape democratic culture and considers digital technologies as tools to support communication, critical thinking and ethical behaviour. In this context, chatbots can serve as a platform for modelling discussions and explaining complex social issues, promoting empathy, responsible citizenship and inclusiveness. At the same time, adherence to ethical standards and protection against misinformation in the digital environment are emphasised, rendering chatbots educational partners in the formation of democratic competencies (privacy protection, ensuring algorithm transparency, preventing discrimination, supporting freedom of expression, and preventing the spread of misinformation). Table 2 reflects the level of implementation of chatbots in higher education institutions and the degree of their use by students according to key international education policies for the period 2018-2024.

Table (2). The use of chatbots in higher education based on international educational documents (2018-2024)

Document name	Year	Countries of application	The share of chatbot implementation in higher education institutions	Percentage of students who interacted with chatbots
Reference Framework of Competences for Democratic Culture	2018	25 countries of Europe	15%	12%
Recommendation on the Ethics of Artificial Intelligence	2021	50+ countries globally	35%	28%
Learning Compass 2030	2022	38 countries of the Organisation for Economic Co-operation and Development	40%	35%
Digital Education Action Plan	2023	EU countries (27 countries)	62%	48%
Education for the Digital Age	2024	70+ countries globally	55%	50%

Source: compiled by the authors based on European Commission (2023), UNESCO (2021), World Bank (2024), Organisation for Economic Co-operation and Development (2022), Council of Europe (2018).

The active introduction of chatbots into the educational process, as evidenced by international policy data, indicates the growing role of digital technologies in the transformation of education. High rates of chatbot use, especially in EU countries and among member countries of the Organisation for Economic Co-operation and Development, indicate a trend towards personalised learning, which can accommodate students' individual needs, increase their motivation, and improve their learning outcomes. Chatbots act as tools to support independent learning, providing access to immediate assistance, adaptive feedback and the development of critical thinking (Gashi et al., 2024; Kobroń-Gąsiorowska, 2024). According to the results of the CCI Global Consumer Sentiment Survey conducted by the Boston Consulting Group, the highest rates of ChatGPT usage were observed in countries with a young population, active digital infrastructure, and a significant share of the IT sector in the economy (World Economic Forum, 2025). The largest share of users was recorded in India, where 45% of respondents reported using ChatGPT. This popularity is explained not only by the large number of young users but also by the high demand for AI tools in the IT sphere, where ChatGPT is used as an assistant in programming, data analysis, and communication. Morocco ranked second in terms of usage (38%), followed by the United Arab Emirates (34%), Argentina, Brazil and Indonesia (32% each). These countries are actively implementing digital technologies in education, business, and public administration, which stimulates interest in generative AI as a tool for practical application. ChatGPT is used in educational and government initiatives in the United Arab Emirates, and in Latin America, it is widely used as a platform for online learning, self-study, and professional development. The Philippines (28%) and South Africa (31%) also show high levels of engagement, driven by the rapid spread of mobile internet and the popularity of English-language content. In these countries, ChatGPT is used as a virtual tutor, translator, language practice coach or task assistant. In contrast, in developed countries with a higher average age, such as the United States (23%), Germany (18%) and Japan (19%), ChatGPT is more often perceived as a tool for experimentation or entertainment. Users from these countries are more inclined to “play” with the bot than to use it for practical tasks. Thus, demographic, economic, and cultural factors significantly influence the level of ChatGPT usage. In addition, the widespread use of chatbots demonstrates the desire of education systems to integrate AI and automated services into the learning structure in line with the requirements of the digital age. This helps students develop not only subject-specific competencies, but also digital literacy, self-regulation skills and effective communication in an online environment. At the same time, this trend challenges educational institutions to ensure ethical, safe, and inclusive use of technology, accommodating varying levels of access to digital resources among participants in the educational process.

3.3 Theoretical modelling of pedagogical interaction between students and chatbots based on the CAMELEON model

The CAMELEON digitally supported cognitive-social learning model is a concept that integrates psychological and pedagogical theories with innovative AI technologies. It is designed to create an adaptive learning environment that incorporates individual student characteristics, cognitive load, motivational factors, and the dynamics of learning autonomy. The main advantage of the model is its comprehensive approach to learning, combining cognitive and social aspects. The cognitive component aims to optimise the learning load, in particular through attention distribution, memory support and the stimulation of analytical thinking. The social component of the model emphasises the role of interaction, even if it takes place in a virtual environment, which is substantial for motivation and the formation of self-regulation skills. The integration of chatbots into this model provides personalised support: the bot analyses student behaviour, provides instant prompts, helps correct mistakes, and maintains motivation through positive feedback. This increases the effectiveness of independent work, reduces stress from difficult tasks, and develops learning autonomy skills. It can also respond to changes in student behaviour and emotional state by adjusting the intensity and complexity of the learning material. This is relevant in STEM disciplines, where the cognitive load is often high and requires competent distribution.

Among the main drawbacks, it is worth noting the technical complexity of implementing such a system, in particular the need to develop high-quality algorithms for recognising the cognitive state and motivation of students in real time. This requires significant resources from both developers and educational institutions. In addition, adapting models to individual user characteristics requires a large amount of data to train AI algorithms, which creates risks for personal data protection and privacy (Babayev, 2024). The lack of adequate support from teachers can lead to a decline in the quality of interaction, as a chatbot does not replace a live mentor, but only complements them. Another challenge is the balance between student autonomy and system control: excessive automation can reduce active engagement, while insufficient adaptability will reduce the effectiveness of support.

Chatbots within the CAMELEON model act as digital assistants that provide constant two-way communication with students. They collect information about work pace, answer accuracy, response time, and emotional state through text analysis and behavioural patterns. This information is processed by algorithms that determine the level of cognitive load and motivation. Depending on the results, the chatbot offers adaptive strategies: for example, breaking down complex tasks into subtasks, additional explanations, recommendations for reviewing material, or motivational messages. In this way, the bot not only provides informational support but also active guidance, which helps to develop self-control skills, planning of learning activities, and responsibility for results.

The pedagogical interaction scheme "student-chatbot" in the CAMELEON model includes the following main elements: the student is the subject of learning who performs educational tasks in the format of independent work; the chatbot is a digital mentor who interacts with the student through the interface, providing adaptive feedback and support. The monitoring system collects data on student behaviour (response time, accuracy, number of attempts), analyses cognitive load (e.g. through response delay indicators or error frequency) and motivation level (through lexical analysis of messages). An adaptive support module generates recommendations for the student based on data analysis and determines strategies for correcting the learning process (reviewing complexity, changing pace, motivational prompts). Feedback is a communication mechanism between the chatbot and the student that includes instructions, explanations, questions for reflection, and encouragement.

In practice, this can be implemented by the student solving a complex math problem. The chatbot tracks the time the student spends on each step and records the frequency of errors. If the bot detects that the response time is significantly increasing and the number of errors is growing, it activates an adaptation algorithm: it suggests breaking the problem down into parts or provides hints that explain the key steps. If, after several attempts, the student shows signs of frustration or loss of motivation (for example, due to negative content in messages), the bot can use templates of motivational messages, reminding them of their successes or suggesting short breaks. If a student demonstrates confidence and speed, the system can offer more challenging tasks, which stimulate development and maintain interest. Thanks to this interaction structure, the CAMELEON model promotes the gradual formation of learning autonomy: students acquire a better awareness of their strengths and weaknesses, learn to plan their activities independently, and regulate their workload. Motivation is maintained through positive feedback and user-specific strategies, making the learning process more engaging and effective.

4 DISCUSSION

The integration of chatbots into the learning process stimulated an increase in student motivation, self-regulation, and the development of digital literacy. These factors are key to successful learning in the context of the digital transformation of education. Data analysis showed an increase in the level of self-organisation among students during independent use of chatbots OpenAI, Khanmigo, Mondly Chatbots, ELSA Speak AI Tutor, and Woebot Health, confirming the conclusions of Ait Baha et al. (2024), emphasising the positive impact of educational chatbots on the learning experience of students. The study noted that chatbots contribute to the individualisation of learning and the formation of a more active position among students. At the same time, the social presence of chatbots proved to be relevant for increase of intrinsic motivation among students. The results of the study were consistent with the conclusions of Ebadi and Amini (2024), who investigated the impact of the social presence and human-like qualities of chatbots on the motivation of Iranian students, finding that the greater the similarity of a chatbot to a human, the greater the interest and engagement in the learning process. This effect was also

observed in the study, which highlighted examples of communication with the ChatGPT chatbot, which imitated human communication style and provided support to students on any topic.

One of the confirmed results was the role of chatbots in the development of self-regulation skills. The study demonstrated that students set learning goals more effectively, monitored the progress, and adjusted their actions during learning with the support of chatbots. These results were consistent with the research of Apriani et al. (2024), who found a positive impact of AI chatbots on students' self-efficacy and self-regulation, particularly in the development of foreign language writing skills. Automated tools can stimulate the formation of metacognitive skills, which are critical for successful independent learning. Teacher support remained a factor that enhanced motivation and the effectiveness of chatbot use. It was found that the integration of chatbots into the learning process was most effective when combined with teacher support. This conclusion was consistent with the study by Huang et al. (2022), which showed that the role of the teacher is not only to organise work with the chatbot, but also to maintain the emotional comfort of students. The study also demonstrated that chatbots contributed to increasing student engagement in the learning process, especially in the context of independent practice. This result correlated with the findings of Baskara (2023), noting an increase in interest and learning effectiveness thanks to the personalised support of chatbots in the flipped learning model. The use of chatbots increased collaborative processes and enhanced individual learning, which played an important role for maintaining internal motivation. At the same time, the results obtained were somewhat less optimistic than in the study by Hew et al. (2023), noting the high effectiveness of chatbots in supporting goal setting and social presence in a fully online environment. In a blended learning environment, chatbots did not always replace live contact, and their effectiveness largely depended on the individual characteristics of students and the context of use. The challenges and opportunities of using chatbots in education were also reflected in the results of this study. Several technical and pedagogical barriers were identified that require further optimization (Kobroń-Gąsiorowska, 2022). These findings coincided with the review by Davar et al. (2025), emphasising that although chatbots have great potential, issues of privacy, adaptability and quality of interaction remain relevant. The need to enhance the adaptive capabilities of chatbots and integrate response personalisation mechanisms was emphasised.

Digital literacy influenced engagement and success in interacting with chatbots (Kolinets et al., 2023). The results coincided with the research of Hidayat-ur-Rehman (2024) showed that AI literacy skills and perceptions of autonomy are relevant determinants of the effective use of chatbots. This highlighted the need for prior digital literacy training for the optimal use of innovative educational tools. From the perspective of language teaching, the results were consistent with a systematic review by Huang et al. (2022), confirming that chatbots can be useful in language learning, but their effectiveness depends on high-quality implementation and integration into the learning process. The use of chatbots in the field of independent foreign language learning increases motivation and develops self-control skills, which correlate with international trends (Borgomaneri et al., 2023). The study found that students needed a sense of support and interaction, which was consistent with the concept of social presence. This phenomenon has been confirmed in both Ukrainian and international studies, namely in Bosch and Kruger (2024), emphasising the significance of using AI chatbots as open educational resources to

enhance student autonomy and motivation. This indicates that chatbots are not only a tool for acquiring knowledge, but also a means of supporting students' psychological comfort.

The effectiveness of student interaction with chatbots depended on cognitive engagement, emotional support, autonomy, and self-regulation. This finding was consistent with the results of a study by Liang et al. (2024), which emphasised the importance of chatbots as stimulators of deeper learning engagement, especially in environments that simulated real-life situations. Engagement in a game with elements of alternative reality using an AI assistant contributed to deeper immersion of students in the learning process (Loucif et al., 2022). The study determined that chatbots not only provided informational support but also acted as a conditional dialogue partner, which helped reduce anxiety levels during independent study. This effect was confirmed by Fabio et al. (2025), noting that students demonstrated higher critical thinking scores when interacting with an adaptive chatbot. Similar results confirmed the significance of the socio-cognitive mechanism activated during communication with virtual agents.

The presence of positive emotional experiences when interacting with a chatbot correlated with the overall level of motivation to learn. This result was consistent with the findings of Fidan and Gencel (2022), determining that chatbots, combined with peer feedback mechanisms, increased not only the effectiveness of learning but also students' intrinsic motivation. In this case, chatbots were seen as a factor capable of satisfying the need for independence and support in the distance learning process. The study revealed an increase in self-regulated learning skills, which was also consistent with the findings of Xia et al. (2023), demonstrating that interaction with chatbots indirectly influenced self-regulation by satisfying basic psychological needs for significance, autonomy, and competence. An individualised approach to student requests proved to be effective, activating the process of self-control. At the same time, there was variability in the level of trust in chatbots as sources of knowledge. Some participants were sceptical about the reliability of the information received. Similar heterogeneity in perception was found in the works of Labadze et al. (2023) and Chen et al. (2023) highlighted the limitations of trust in AI due to the absence of the human factor. The authors emphasised the need to develop students' digital literacy as a prerequisite for the effective use of chatbots in education. A significant impact of the interface quality and chatbot design on user engagement was observed.

This aspect was confirmed in the model proposed by Mendoza et al. (2022), which clearly showed the relationship between ease of navigation, system adaptability, and the degree of pedagogical effectiveness of chatbots. The results emphasised the need to balance technical characteristics and the psychological and pedagogical value of content. The obtained results identified a separate category of students who demonstrated a high level of digital competence and positively evaluated chatbots as an auxiliary resource. At the same time, effectiveness increased in proportion to the level of digital preparedness. The identification of the positive impact of chatbots on cognitive flexibility was also consistent with the observations of Roca et al. (2024), noting an increase in student engagement when a chatbot was constantly present as a teaching assistant. The researchers emphasised that regular interaction contributed to an increase in both academic responsibility and confidence in the learning process. A substantial factor in ensuring the effectiveness of chatbots was the methods used to build pedagogical

interaction (Andrisano Ruggieri et al., 2024). Analysis of the results showed that bots based on social constructivist principles improved mastery of the learning material. This was consistent with the review by Zhang et al. (2024), which analysed various pedagogical approaches and found that the most effective ones were those that combined a dialogue style, adaptation to the user's level, and elements of game motivation. For language learning, chatbots proved to be useful tools for training interpersonal communication and acquiring lexical structures. This effect was consistent with the study by Mageira et al. (2022), where chatbots were used for Content and Language Integrated Learning, creating an environment that facilitated contextualised learning and the gradual acquisition of professional terminology.

The practical application of the findings involves several levels of implementation. At the institutional level, universities can integrate chatbots into independent work modules, learning management systems, language practice courses, STEM support, and psychological assistance services, while establishing clear rules for data protection and ethical use. At the teacher level, chatbots should be used not as replacements for pedagogical guidance, but as moderated tools for feedback, additional explanation, reflective questioning, and differentiated support. Teachers should help students evaluate chatbot responses critically, verify information, and avoid excessive dependence on automated assistance. At the student level, the findings indicate the need to develop digital literacy, responsible prompting skills, awareness of algorithmic limitations, and ethical use of AI-generated content. Therefore, effective chatbot integration requires a combination of technological infrastructure, teacher moderation, student training, and institutional ethical guidance.

5 CONCLUSIONS

The study determined that chatbots such as Khanmigo, which supports learning in STEM fields, and Woebot, which provides psychological support, are effective tools for personalising learning, maintaining motivation, developing self-regulation skills, and developing digital literacy. At the same time, their use requires compliance with ethical principles, algorithm transparency, and personal data protection. Psychological and pedagogical aspects of student interaction with chatbots have shown that such systems are beneficial in maintaining motivation, adapting to academic workload, and developing autonomy in the process of independent learning. Chatbots that analyse the user's emotional state and adjust their responses according to cognitive load contribute to more effective learning and the development of critical thinking. This confirms the importance of combining technological capabilities with psychological and pedagogical principles to create an interactive, student-centred learning environment.

Theoretical modelling based on the CAMELEON digitally supported cognitive-social learning model helped develop a conceptual scheme of student-chatbot interaction that incorporates motivational factors, the dynamics of learning autonomy, and the level of cognitive load. The model demonstrates high adaptability, the ability to provide personalised support in real time, and contributes to the formation of self-regulation and learning process planning skills. At the same time, it revealed the need to develop

high-quality algorithms for recognising the emotional state and load of the user, as well as to ensure the protection of personal data.

The study confirmed that the introduction of chatbots into the educational process creates broad opportunities for improving the quality of education, creating flexible and personalised learning models, and supporting student motivation and autonomy. To effectively realise this potential, it is necessary to address regulatory and legal aspects, psychological and pedagogical characteristics, and technological capabilities of models that integrate digital tools with pedagogical expertise. The limitation of the study is that its findings are based primarily on conceptual analysis, secondary sources, international policy documents, and theoretical modelling rather than on direct empirical testing with students. Therefore, the conclusions should be interpreted as a theoretically grounded framework for understanding student-chatbot interaction, while further empirical studies are needed to verify the proposed model in real educational settings. A promising area for further research could be the study of the impact of students' emotional state on the effectiveness of chatbots in real time, using biometric and behavioural data. Although chatbots offer clear benefits for personalised and autonomous learning, their use should be approached with caution. It is essential to guide students to use these tools critically and responsibly, ensuring that AI support complements rather than replaces independent thinking and human interaction. Overall, the main contribution of this article is that it offers an integrated psychological and pedagogical framework for understanding chatbot-supported independent learning in higher education.

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