

IMPROVING THE METHODOLOGY OF USING EDUCATIONAL CHATBOTS IN THE LEARNING PROCESS

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Received: 02 Oktabr 2026

Accepted: 07 Oktabr 2026

Published: 12 Oktabr 2026

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Iqtibos uchun: Hamroyev, B. B. IMPROVING THE METHODOLOGY OF USING EDUCATIONAL CHATBOTS IN THE LEARNING PROCESS / B. B. Hamroyev // Buxoro xalqaro universiteti ilmiy axborotnomasi. — 2026. — T. 10, № 1. — B. 378–383.

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Abstract. Students of higher education institutions increasingly use generative chatbots spontaneously, without methodological support from the teacher, which often reduces their independent cognitive activity and leads to the uncritical copying of ready-made answers. To develop and substantiate an improved methodology for using educational chatbots in the learning process of higher education. Theoretical analysis and generalization of scientific and methodological literature, systematic reviews and meta-analyses, pedagogical modeling, the systems-structural approach, and generalization of the author's own teaching experience. A structural model of the methodology consisting of target, content, procedural, and diagnostic components is proposed. The procedural component is implemented as a three-stage cycle of chatbot use (before class, in class, and after class). A five-step algorithm for the teacher's preparation of a chatbot is described, five types of learning tasks that preserve the learner's intellectual activity are systematized, and criteria and indicators of effectiveness are developed. A chatbot becomes a tool for developing thinking rather than replacing it when its use is subordinated to the planned learning outcomes of the course, limited by an instruction written by the teacher, and combined with tasks in which the final intellectual product is created by the student.

Keywords: educational chatbot, teaching methodology, generative artificial intelligence, methodological model, Socratic dialogue, system prompt, independent work, feedback, criteria of effectiveness, higher education.

TA'LIM JARAYONIDA O'QUV CHATBOTLARIDAN FOYDALANISH METODIKASINI TAKOMILLASHTIRISH

Annotatsiya. Oliy ta'lim muassasalari talabalari generativ chat-botlardan o'qituvchining metodik yo'l-yo'riqisiz, stixiyali ravishda foydalanmoqda. Bu ko'pincha mustaqil bilish faolligining pasayishiga va tayyor javoblarning tanqidsiz ko'chirilishiga olib kelmoqda. Oliy ta'lim o'quv jarayonida ta'limiy chat-botlardan foydalanishning takomillashtirilgan metodikasini ishlab chiqish va asoslash. Ilmiy-metodik adabiyotlar, tizimli sharhlar va meta-tahlillarni nazariy tahlil qilish va umumlashtirish, pedagogik modellash, tizimli-strukturaviy yondashuv, muallifning shaxsiy pedagogik tajribasini umumlashtirish. Maqsadli, mazmuniy, protsessual va diagnostik komponentlardan iborat metodikaning strukturaviy modeli taklif etildi. Protsessual komponent chat-botdan foydalanishning uch bosqichli sikli (darsdan oldin, darsda, darsdan keyin) sifatida amalga oshiriladi. O'qituvchining chat-botni tayyorlashining besh bosqichli algoritmi tavsiflandi, ta'lim oluvchining intellektual faolligini saqlaydigan o'quv topshiriqlarining besh turi tizimlashtirildi, metodika samaradorligini baholash mezonlari, ko'rsatkichlari va darajalari ishlab chiqildi. Chat-bot fikrlashni almashtiruvchi emas, balki uni rivojlantiruvchi vositaga aylanishi uchun undan foydalanish kursning rejalashtirilgan natijalariga bo'ysundirilishi, o'qituvchi yozgan yo'riqnoma bilan chegaralanishi va yakuniy intellektual mahsulotni talabning o'zi yaratadigan topshiriqlar bilan uyg'unlashtirilishi lozim.

Kalit so'zlar: ta'limiy chat-bot, o'qitish metodikasi, generativ sun'iy intellekt, metodik model, sokratik dialog, tizimli yo'riqnoma (system prompt), mustaqil ish, qayta aloqa, samaradorlik mezonlari, oliy ta'lim.

СОВЕРШЕНСТВОВАНИЕ МЕТОДИКИ ИСПОЛЬЗОВАНИЯ ОБРАЗОВАТЕЛЬНЫХ ЧАТ-БОТОВ В УЧЕБНОМ ПРОЦЕССЕ

Аннотация. Студенты высших учебных заведений всё чаще используют генеративные чат-боты стихийно, без методического сопровождения преподавателя, что нередко снижает самостоятельную познавательную активность и приводит к некритичному копированию готовых ответов. Разработать и обосновать усовершенствованную методику использования образовательных чат-ботов в учебном процессе высшего учебного заведения. Теоретический анализ и обобщение научно-методической литературы, систематических обзоров и метаанализов, педагогическое моделирование, системно-структурный подход, обобщение собственного педагогического опыта автора. Предложена структурная модель методики, состоящая из целевого, содержательного, процессуального и

диагностического компонентов. Процессуальный компонент реализуется в виде трёхэтапного цикла использования чат-бота (до занятия, на занятии, после занятия). Описан пятишаговый алгоритм подготовки чат-бота преподавателем, систематизированы пять типов учебных заданий, сохраняющих интеллектуальную активность обучающегося, разработаны критерии, показатели и уровни оценки эффективности методики. Чат-бот становится средством развития мышления, а не его замены, если его использование подчинено планируемым результатам курса, ограничено инструкцией преподавателя и сочетается с заданиями, в которых итоговый интеллектуальный продукт создаёт сам студент.

Ключевые слова: образовательный чат-бот, методика обучения, генеративный искусственный интеллект, методическая модель, сократический диалог, системная инструкция (system prompt), самостоятельная работа, обратная связь, критерии эффективности, высшее образование.

Introduction. The digital transformation of higher education has made chatbots based on large language models an everyday tool for students. In the Republic of Uzbekistan, the expansion of digital technologies in education is defined as one of the priority directions of the Development Strategy of New Uzbekistan for 2022–2026 [1]. Students of technical and exact disciplines today actively use generative chatbots to explain theoretical material, write and debug program code, and solve practical problems. However, in most cases this use occurs spontaneously, outside the framework of the course and without methodological guidance from the teacher.

The spontaneous use of chatbots has a dual character. On the one hand, a student receives an explanation at any time of the day, at an individual pace and in a convenient form, which is especially valuable in large groups where the teacher physically cannot answer every question. On the other hand, when the chatbot is used without clear rules, the student easily turns from an active participant of cognition into a consumer of ready-made solutions: the task is formally completed, but the corresponding knowledge and skills are not formed. For the teacher, this creates a new problem of assessment, since the submitted work no longer reliably reflects the student's real level of preparation.

Our previous research examined the role of chatbots in education, their classification by the principle of dialogue construction, and the main directions of their application [2]. It was concluded that the educational effect of a chatbot is determined not so much by its technical characteristics as by the pedagogically sound organization of its use. This conclusion raises a practical question: how exactly should a teacher organize work with a chatbot so that it develops, rather than replaces, the learner's independent thinking?

International studies confirm the urgency of this question. Systematic reviews note that educational chatbots are often introduced into practice without sufficient theoretical and methodological grounding [3; 4], while researchers of large language models emphasize that their benefits for education can only be realized if teachers master new methodological competencies and learners develop critical thinking skills [5]. The UNESCO guidance on generative artificial intelligence in education also stresses the need for a human-centered approach and for pedagogical validation of such tools before their use in the classroom [6].

Thus, there is a contradiction between the widespread spontaneous use of chatbots by students and the lack of a methodology that integrates this tool into the structure of the learning process in a purposeful way. The purpose of this article is to develop and substantiate an improved methodology for using educational chatbots in the learning process, including a structural model, an algorithm for preparing a chatbot, a system of learning tasks, and criteria for evaluating effectiveness.

Methods. The theoretical basis of the study consisted of systematic reviews and meta-analyses of the effectiveness of educational chatbots and intelligent tutoring systems [3; 4; 7; 8; 9], works on the role of feedback in learning [10], and regulatory documents on the digitalization of education. The study used methods of theoretical analysis and generalization of scientific and methodological literature, pedagogical modeling, the systems-structural approach, and generalization of the author's own teaching experience in courses of the Department of Exact Sciences and Digital Technologies.

The object of the study is the learning process in higher education under conditions of digitalization; the subject is the methodology of using educational chatbots as a means of supporting and developing students' independent cognitive activity.

The research was carried out in three stages. At the first, analytical stage, scientific publications and regulatory documents were studied, the experience of using chatbots in foreign and domestic universities was generalized, and the main risks of their spontaneous use were identified. At the second, modeling stage, the structural model of the methodology, the algorithm for preparing a chatbot, and the system of learning tasks were designed on the basis of the systems-structural approach. At the third, generalizing stage, the elements of the methodology were refined in the course of the author's teaching practice, and a system of criteria and indicators for evaluating its effectiveness was developed.

The methodology was designed on the basis of the following principles: the leading role of the teacher, who determines the goals, content, and limits of the chatbot's use; alignment of the chatbot's content with the course working program; priority of the learner's own intellectual activity over obtaining a ready-made answer; transparency of the chatbot's use, which implies that students know in advance in which tasks and to what extent the chatbot may be used; and continuous diagnostics with subsequent correction of the methodology.

Results. The study made it possible, first, to construct a structural model of the methodology for using educational chatbots; second, to determine the algorithm for the teacher's preparation of a chatbot for a specific course; third, to systematize the types of learning tasks that preserve the learner's intellectual activity; and fourth, to develop criteria and indicators for evaluating the effectiveness of the methodology.

The structural model of the methodology includes four interrelated components (Figure 1). The target component defines the planned learning outcomes of the course, to which the use of the chatbot is subordinated. The content component determines the knowledge base of the chatbot: lecture materials, typical tasks, and reference answers aligned with the working program. The procedural component describes the stages and forms of interaction between the student, the chatbot, and the teacher. The diagnostic component provides for the analysis of results and the correction of the methodology.

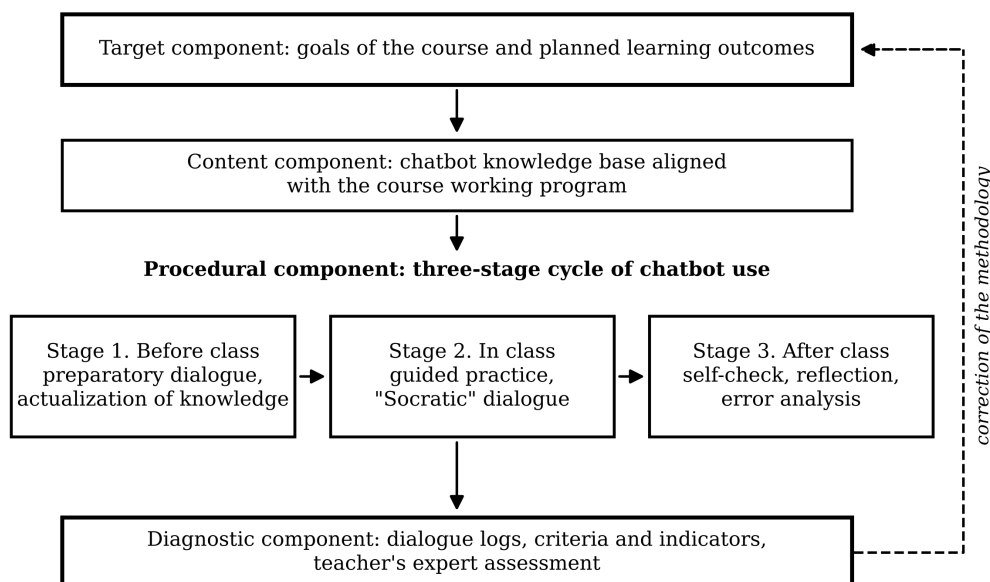


Figure 1. Structural model of the methodology for using educational chatbots in the learning process

Source: developed by the author.

The key element of the model is the procedural component, implemented as a three-stage cycle that covers the entire learning cycle of a topic.

The first stage - before class (preparatory). At this stage, the chatbot is used to actualize the students' basic knowledge and to prepare them for the perception of new material. The teacher gives the students a short list of guiding questions on the upcoming topic, which they discuss with the chatbot. The chatbot is configured not to give a complete solution but to ask counter-questions and refer to the relevant section of the lecture. As a result, students come to class with a formed set of questions, and the teacher, after reviewing the anonymized dialogue logs, sees which concepts cause the greatest difficulty.

The second stage - in class (guided practice). During a practical or laboratory session, the chatbot acts as a "Socratic" assistant: when a student encounters difficulty, the chatbot does not provide the final answer but leads the student to it through a sequence of hints and clarifying questions. For example, in a programming course, when an error occurs in the code, the chatbot first asks the student to explain what each line should do, then points to the area where the error is located, and only after repeated unsuccessful attempts gives an explanation of its cause. The teacher in this case focuses on students who need expert help, while typical difficulties are handled by the chatbot. Such a combination of digital tools with interactive methods corresponds to the logic of the staged organization of practical classes described in [11].

The third stage - after class (reflective). After class, the chatbot is used for self-checking, error analysis, and reflection. The student completes control questions, receives immediate feedback, and formulates in their own words what they learned and what remains unclear. Immediate and specific feedback is one of the most powerful factors affecting learning outcomes [10], and the chatbot makes it possible to provide such feedback to every student regardless of group size.

The distribution of functions among the participants of the learning process at each stage of the cycle is presented in Table 1. It shows that the chatbot does not replace the teacher at any stage: it takes over routine and repetitive support, while goal-setting, expert assistance, and final assessment remain with the teacher.

Table 1.

Distribution of functions among the teacher, the chatbot, and the student at the stages of the cycle

Stage	Teacher	Chatbot	Student
Before class	Formulates guiding questions; reviews anonymized dialogue logs	Asks counter-questions; refers to sections of the lecture	Discusses questions; forms a list of difficulties
In class	Provides expert help to students who need it; organizes discussion	Leads the student to the solution through hints (Socratic dialogue)	Solves tasks independently; explains own reasoning
After class	Analyzes typical errors; corrects	Provides immediate feedback on	Performs self-check and reflection

Stage	Teacher	Chatbot	Student
	the course materials	control questions	in own words

Source: developed by the author.

The effectiveness of the methodology largely depends on the quality of the teacher's preliminary preparation of the chatbot. The proposed algorithm for this preparation consists of five steps (Figure 2).

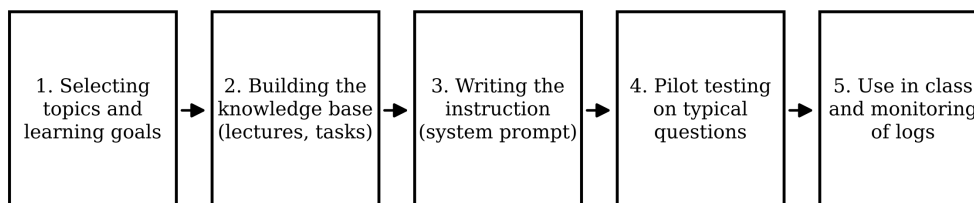


Figure 2. Algorithm for the teacher's preparation of an educational chatbot for a course

Source: developed by the author.

At the first step, the teacher selects the topics of the course for which the use of a chatbot is pedagogically justified and formulates the learning goals for each. At the second step, a knowledge base is created: lecture notes, problem sets, typical errors, and reference solutions, which allows the chatbot's answers to be tied to the content of the specific course rather than to general information from the internet. At the third step, the teacher writes the chatbot's instruction (system prompt), which defines its role, the limits of permissible assistance, and the style of dialogue. An example of such an instruction for a programming course is as follows: "You are an assistant for the course 'Programming Fundamentals'. Do not write a complete solution to the task for the student. First ask the student to explain their own approach; then point to the part of the code where the error is; give a direct explanation only after two unsuccessful attempts. Use only the materials of the course. If a question is outside the course, recommend contacting the teacher." At the fourth step, the chatbot is tested on a set of typical and deliberately "difficult" questions in order to identify inaccurate answers and violations of the instruction. At the fifth step, the chatbot is used in the learning process, and the teacher regularly analyzes the dialogue logs.

A central place in the methodology is occupied by learning tasks designed so that the chatbot supports the learner's thinking rather than replacing it. The types of such tasks are systematized in Table 2.

Table 2.

Types of learning tasks using a chatbot that preserve the learner's intellectual activity

Task type	Content of the task	Developed skill
"Explain to the chatbot"	The student explains a concept or algorithm to the chatbot, which plays the role of a learner and asks clarifying questions	Deep understanding, ability to formulate thoughts
"Find the error"	The chatbot generates a solution or code with deliberately introduced errors; the student must find and correct them	Critical thinking, analysis
"Check the chatbot"	The student verifies the chatbot's answer against the lecture material and other sources and assesses its accuracy	Information verification, critical evaluation
Socratic dialogue	The chatbot leads the student to the solution through a sequence of questions without giving the final answer	Independent problem solving
Compare the approaches	The student solves the task independently, then compares their solution with the chatbot's and justifies the differences	Reflection, self-assessment

Source: developed by the author.

The common feature of all the presented task types is that the final intellectual product (an explanation, a corrected solution, a justified evaluation) is created by the student, while the chatbot serves as an interlocutor, a source of material for analysis, or a means of feedback. This makes it possible to reduce the risk of the mechanical copying of answers, which is one of the main concerns associated with the use of generative models in education [5].

To evaluate the effectiveness of the methodology, a system of criteria and indicators is proposed (Table 3). The evaluation is carried out on the basis of a combination of test results, analysis of dialogue logs, questionnaires, and the teacher's expert assessment.

Table 3.

Criteria and indicators for evaluating the effectiveness of the methodology

Criterion	Indicators	Diagnostic tools
Cognitive	Completeness and depth of knowledge of the topic; ability to apply knowledge in solving practical problems	Tests, control tasks, practical work
Activity-based	Share of questions to the chatbot requesting explanation rather than a ready-made answer; independence in solving tasks	Analysis of dialogue logs, observation
Motivational	Interest in the course; regularity of independent work; willingness to ask questions	Questionnaires, activity statistics
Reflexive-critical	Ability to assess the accuracy of the chatbot's answer, find errors, and justify one's own position	"Check the chatbot" and "Find the error" tasks

Source: developed by the author.

For each criterion, three levels of formation are distinguished: low (the student uses the chatbot mainly to obtain ready-made answers and does not verify them), medium (the student asks clarifying questions and partially verifies the answers), and high (the student uses the chatbot as an interlocutor for testing their own hypotheses and critically evaluates its answers). The transition of students from lower to higher levels serves as the main indicator of the effectiveness of the methodology.

Discussion. The proposed methodology differs from the spontaneous use of chatbots in three main respects. First, the chatbot is integrated into all stages of the learning cycle of a topic rather than being used only as an episodic source of answers. Second, the limits of the chatbot's assistance are determined in advance by the teacher through the system prompt and the knowledge base, which aligns its content with the working program and reduces the risk of unreliable information. Third, the system of learning tasks transfers the emphasis from obtaining an answer to the learner's own intellectual activity.

The methodology is consistent with the results of empirical studies. A meta-analysis by Wu and Yu showed that AI chatbots have a significant positive effect on learning outcomes, with the effect being more pronounced in short-term interventions and in higher education [8]. A meta-analysis of intelligent tutoring systems by Kulik and Fletcher demonstrated that systems providing step-by-step guidance and feedback significantly increase student achievement compared with traditional instruction [9]. These results indirectly confirm the validity of the "Socratic" model of chatbot behavior proposed in this methodology, since it reproduces the principle of step-by-step tutoring, the effectiveness of which was noted by B. Bloom in his work on the "2 sigma problem" [12].

The methodology also takes into account the main risks identified in the literature. The risk of unreliable or "hallucinated" answers is reduced by binding the chatbot to the course knowledge base and by the pilot testing step of the algorithm; in addition, the "Check the chatbot" task turns possible inaccuracies into material for developing critical thinking. The risk of academic dishonesty is reduced by the transparency principle and by task types in which a ready-made answer from the chatbot does not in itself constitute completion of the assignment. The risk of reduced communication between the teacher and students is offset by the fact that the time freed from routine consultations is redirected to individual work with students who need expert help.

At the same time, the implementation of the methodology requires certain conditions to be met. The teacher must possess basic competencies in writing instructions for language models and analyzing dialogue logs; the educational institution must ensure the protection of students' personal data; and the rules for the permissible use of chatbots in completing assignments must be openly communicated to students. In addition, the methodology does not eliminate the need for the teacher's expert assessment: the final evaluation of the depth of understanding, the formation of a value-based attitude toward the discipline, and work with individual difficulties remain the teacher's prerogative. The prospect of further research lies in the experimental verification of the methodology in courses of exact and technical disciplines and in the quantitative assessment of the dynamics of students' levels according to the proposed criteria.

Conclusion and recommendations. Thus, the improvement of the methodology for using educational chatbots consists in moving from their spontaneous use by students to purposeful integration into the structure of the learning process. The proposed structural model, which includes target, content, procedural, and diagnostic components, makes it possible to subordinate the use of the chatbot to the planned learning outcomes of the course. The three-stage cycle (before class, in class, after class) ensures the continuity of support for the learner, and the algorithm for preparing the chatbot allows the teacher to align its content with the working program and to set the limits of permissible assistance.

The systematized types of learning tasks ("Explain to the chatbot", "Find the error", "Check the chatbot", Socratic dialogue, comparison of approaches) ensure that the chatbot functions as a tool for developing the learner's thinking rather than replacing it, while the developed criteria and indicators make it possible to evaluate the effectiveness of the methodology objectively.

Based on the results of the study, the following recommendations can be made: to include modules on designing educational chatbots and writing system prompts in teacher professional development programs; to define in course syllabi the rules for the permissible use of chatbots in completing assignments; to begin implementation with a limited number of course topics and to expand it gradually based on the analysis of dialogue logs; and to combine chatbot-based tasks with traditional forms of control that verify the student's independent mastery of the material. The application of the

proposed methodology contributes to improving the quality of education, developing students' independence and critical thinking, and rationally distributing the workload between the teacher and digital learning tools.

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