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Integrating AI chatbots in teaching: A case study on enhancing students' information technology competence

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ABSTRACT

Recent years have seen a growing trend in research on artificial intelligence (AI)-powered chatbots as innovative tools in education and training, highlighting their potential to personalize learning and support learner autonomy. This study examines the transformative potential of AI-powered chatbots in reshaping education by fostering autonomous, self-directed learning. It explores how chatbots move beyond interactive engagement to enable deeper, independent learning experiences. A threefold research approach was adopted. First, a comprehensive review of AI-driven teaching methodologies was conducted. Second, chatbot frameworks were designed to enhance self-paced and personalized learning. Third, the effectiveness of these frameworks was empirically tested through experimental learning environments involving 43 education experts and 320 students. Expert surveys were used to identify essential self-learning competencies, which informed the design of chatbot-supported pedagogical strategies tailored to diverse educational needs. The results reveal that AI-powered chatbots significantly enhance student engagement and promote independent learning. Their ability to provide real-time feedback, personalized support, and adaptive pacing contributes to improved academic performance and learning outcomes. These findings demonstrate that chatbots can play a central role in fostering learner autonomy and transforming traditional educational models. This research underscores the value of integrating AI chatbots into modern teaching practices. Educators and institutions can leverage chatbot technologies to create more personalized, scalable, and effective learning environments that empower students to take greater ownership of their learning processes.

Contribution/Originality: This study uniquely explores how AI chatbots foster autonomous, self-directed learning beyond mere interaction, emphasizing their role in transforming learners from passive recipients to active knowledge constructors an area underexplored in existing research and rarely applied in practical teaching.

1. INTRODUCTION

In education, chatbots act as intelligent agents capable of interacting with learners to answer a variety of questions and provide appropriate responses. Chatbots are used not only to develop students' interaction skills but also to support teaching based on automation. This helps increase connectivity and effectiveness in interactions. Some notable benefits include: (1) content integration support, (2) quick access, (3) motivation and interaction, (4) instant support, and (5) personalization (Okonkwo & Ade-Ibijola, 2021). Integration of artificial intelligence (AI) chatbots

are tools that can communicate and interact with humans through natural language via pre-programmed artificial intelligence systems through computers. With various purposes, chatbots have been used in many fields, including marketing, customer service, healthcare, technical support, as well as education and training.

In recent years, advancements in AI have revolutionized various sectors, with education being one of the most promising areas for transformation. Among the innovations, AI chatbot-supported teaching systems have gained significant attention for their ability to enhance learning experiences, improve accessibility, and personalize education. These systems utilize AI algorithms to simulate human-like interactions, assisting students and educators in ways that traditional methods often cannot achieve. As the demand for adaptable and scalable educational solutions grows, the integration of AI chatbots into teaching systems is poised to become a cornerstone of modern education.

The AI chatbots in education are transforming how students, educators, and institutions engage with learning. AI chatbots, powered by advanced natural language processing and machine learning algorithms, serve as versatile tools that provide personalized learning experiences, streamline administrative processes, and foster enhanced communication. These intelligent virtual assistants are capable of answering queries, offering tailored academic support, and automating routine tasks, enabling educators to focus on more meaningful interactions with students.

As the demand for accessible and flexible learning grows, AI chatbots are becoming indispensable in educational settings. They cater to diverse learner needs, provide 24/7 support, and offer adaptive learning pathways that promote deeper engagement. From virtual tutoring and exam preparation to addressing inquiries about course material, AI chatbots are reshaping traditional educational paradigms, paving the way for more inclusive and innovative learning environments. This exploration of AI chatbots in education highlights their potential to enhance learning outcomes, optimize teaching methodologies, and bridge gaps in educational accessibility.

The argument for adopting AI chatbot-supported teaching systems is grounded in their potential to address key challenges in education. First, they provide individualized learning experiences by analyzing each student's needs, strengths, and weaknesses. For instance, an AI chatbot can offer tailored feedback and supplementary resources, enabling students to progress at their own pace. Second, these systems enhance accessibility by bridging gaps in resources and teacher availability, especially in underserved or remote areas. A chatbot is available 24/7, allowing students to seek help outside traditional classroom hours. Additionally, AI chatbots can alleviate the workload of educators by handling repetitive tasks such as answering frequently asked questions, grading simple assignments, or tracking student performance. This allows teachers to focus on more complex and creative aspects of instruction, fostering a richer learning environment. However, the implementation of such systems must be approached thoughtfully, as concerns about data privacy, the potential for reduced human interaction, and the limitations of AI in addressing complex emotional or ethical issues need to be addressed.

AI Chatbots can make education more accessible by providing on-demand assistance to students, irrespective of time zones or locations. They can deliver personalized learning experiences by tailoring content and responses based on individual learner profiles, improving engagement and comprehension. Many chatbots leverage natural language processing (NLP) to support multiple languages, accommodating diverse learner groups and fostering inclusivity. The ability to analyze user interactions and adapt to learning preferences or challenges sets AI chatbots apart from traditional tools, making them proactive in identifying and addressing student needs. Chatbots in education increasingly integrate with virtual reality (VR), augmented reality (AR), and adaptive learning systems to create immersive and interactive environments. While the benefits are compelling, it is important to acknowledge challenges such as data privacy concerns, the need for ethical AI development, and potential biases in chatbot algorithms. Additionally, there is an ongoing debate about the balance between technology and human interaction in education. Despite these challenges, the contributions of AI chatbots are reshaping education, offering a complementary approach that can transform traditional paradigms into more flexible, inclusive, and learner-centric models.

AI chatbots hold immense promise in transforming education by offering personalized, accessible, and engaging learning experiences. However, realizing their full potential requires addressing technical, ethical, and infrastructural

challenges. Continued research and development in this field will shape the future of educational technology, bridge gaps, and foster inclusive learning environments. The integration of AI chatbot-supported teaching systems in education represents a significant opportunity to transform the way knowledge is delivered and consumed. While challenges exist, the benefits ranging from personalized learning to enhanced accessibility underscore the transformative potential of this technology. As we embrace this innovation, a balanced approach that combines technological advancements with human oversight will be crucial to unlocking its full potential. Based on the synthesis of research results on AI chatbots in education in general, and subject-specific teaching in particular, this article will test and evaluate the feasibility of using AI chatbots to develop self-learning skills in chemistry for students in schools.

2. LITERATURE REVIEW

Artificial intelligence (AI) is a widely used term in the field of information technology (IT) and is utilized in various related fields. The research, development, and application of AI have gone through many different stages.

AI can be understood simply as artificial intelligence, meaning the intelligence of machines created by humans, especially for computers, robots, or electronic computing devices. AI is a field of science and technology aimed at endowing machines with the abilities of human intelligence and reasoning to solve problems, understand communication through language and speech, learn, and adapt on their own (Marr, 2018). McCarthy, Minsky, Rochester, and Shannon (1955) was the first to introduce the term AI as a scientific concept. AI research aims to accurately describe aspects of intelligence processing, learning (to acquire knowledge), and create systems that simulate learning activities and intelligence processing (McCarthy et al., 1955).

Alin-Andrei, in the study, defined Chatbot as a software (machine) that talks to users (humans), also known as a virtual assistant that can answer some user questions (İçöz, Sanalan, Çakar, Benli Özdemir, & Kaya, 2015). Chatbot can also be seen as an intelligent agent capable of interacting with users to answer a variety of questions and provide appropriate responses. It is a computer program that simulates and processes human communication, allowing people to interact with digital devices as if they were talking to a real person. It is a dialogue mechanism that encourages collaborative learning. The automated system responds to human queries. This is another form of accurate data collection. A chatbot can keep a record of students' questions. If students want to know something, they can ask what they want the chatbot to know. This means the chatbot can remember their questions and identify what they like and what they ask repeatedly (Yan et al., 2018). The Chatbot system can be deployed as a mobile web application to support learning. Most foreign literature refers to the concept of Artificial Intelligence in Education (AIED), which translates to AI in education. However, the connotations of these concepts are related to teaching rather than the broad meaning of the term "education" in Vietnamese.

The concept of AI in education emerged around the 1970s (Self, 2016) initially implemented in AI groups, focusing on researching, developing, and evaluating computer software to improve teaching and learning. The long-term goal was to gather feedback from learners, assess learners' abilities and weaknesses, personalize instruction for an individual or group of learners, and ultimately use AI techniques to understand and develop teaching and learning theories (Baker & Siemens, 2014). In 2010, the International AIED Association introduced the concept of AIED as interdisciplinary research "at the intersection of computer science, education, and psychology." It promotes research, develops interactive and adaptive learning environments for learners of all ages and fields (International AIED Society, 2010). This is also the concept understood consistently in all parts of this article.

Tracking learners' activities using AI involves monitoring their behavior and progress during study sessions. One effective tool for this is the AI-based Learner Diagnosis, Support, and Assessment System, which comprises five sub-systems: monitoring, logging, profiling, modeling, and assessing. Each sub-system serves a distinct function, enabling the system to track individual learners, provide feedback, and generate learner profiles based on performance. For instance, the system can identify preferred learning styles such as reading versus watching short videos by

analyzing students' interactions (Koehler & Mishra, 2008). Studies by Ren, Wang, Azlan, and Mao (2024) also highlights the importance of comprehensive evaluation mechanisms and proposes directions for improving teaching assessment and expanding future research samples with blended learning in higher education by examining how offline teaching quality, online instruction, and learning environments influence student satisfaction and learning outcomes.

AI can also support both teachers and students by offering real-time feedback and personalized tutoring assistance. However, it is important to note that AI is not a replacement for teachers. Certain tasks, such as content creation and providing comprehensive study materials, still require human expertise (Verma, 2018).

Furthermore, AI can analyze data collected from students such as survey responses or usage patterns to offer tailored learning resources. This is done through the Recommendation Module (RM), also known as the Recommendation System, which suggests study materials based on learners' needs and progress (Wang, Ma, Liao, & Du, 2017). To effectively implement this, a performance monitoring system is essential for tracking individual learning outcomes and preferences (İçöz et al., 2015). In recent decades, the personalization of education has been notably reflected in the rise of shadow education, where learners' knowledge and competencies have become commodified. This trend has contributed to the growth of private education systems aligned with the development of digital competence and progressive educational foundations (Panagiotis, 2022).

Incorporating chatbots into the teaching organization process will contribute to the "personalization" of learning. This technology can improve interactions among students and encourage interaction with other class members by assigning group tasks and projects, as teachers typically do. Chatbots can assist teachers in answering students' questions, checking their homework or assignments, assigning projects, and especially monitoring the progress and achievements of each learner.

Additionally, chatbots bring other important benefits to the education system in various ways, specifically as follows:

Quick Access: Chatbot encourages quick access to educational information. This is an easy and fast solution to access necessary information, helping to save time, maximize students' learning opportunities, and achievements.

Allowing Multiple Users: One of the main benefits of using Chatbot for educational purposes is allowing multiple users to access simultaneously. According to Rooein (2019) also asserts that a Chatbot can handle multiple queries simultaneously, saving users' time to perform other tasks.

Instant Support: Using chatbots in education allows researchers and students to receive quick answers to their queries and activities. Chatbots can provide immediate support in the learning process for each individual, helping students automate their activities, such as submitting homework, responding to emails, adapting to learners' emotional actions, as well as receiving instant answers to their questions (Okonkwo & Ade-Ibijola, 2021).

Personalized Support: Some studies have shown that using Chatbot technology in education is one of the most important approaches to enhance and promote a more personalized learning experience (Su, Wu, Huang, Hong, & Wang, 2017). A chatbot can provide students with standardized details immediately, such as course content, practice questions, and answers. It can also offer students a personalized learning program and create a more engaging learning environment (Benotti, Martínez, & Schapachnik, 2017). These systems can reduce teachers' administrative workload, allowing them to focus on developing and researching teaching programs.

Since the 1960s, scientists have been researching and developing conversational software to facilitate communication between humans and machines (Shah, Warwick, Vallverdú, & Wu, 2016). With the rapid development of technology, the evolution of conversational software into chatbots and the application of AI technology in chatbots have led to various definitions of AI chatbots. An AI chatbot is an intelligent conversational system capable of processing human language. It is programmed to interact with users like a real person and has the ability to track context and words in the dictionary (Wailthare, Gaikwad, Khadse, & Dubey, 2018). Alternatively, it can comprehend the information inputted by users and respond meaningfully based on pre-loaded knowledge (Kumar & Ali, 2020).

The basic technologies for AI Chatbots are machine learning, natural language processing (NLP), and AI. AI provides many opportunities and allows software to perform tasks like humans. Natural language processing is the foundation of AI-based chatbots. By using complex NLP algorithms, chatbots can process input text: understand, infer, and identify what has been said or written, and then list all relevant actions (Smutny & Schreiberova, 2020).

The integration of AI in education has revolutionized traditional learning paradigms. Among the myriad of AI applications, chatbots have emerged as a transformative tool. These intelligent conversational agents leverage NLP and machine learning (ML) to facilitate communication and learning. This review provides an overview of existing research on the role, effectiveness, challenges, and future potential of AI chatbots in education. The characteristics of AI chatbots in teaching have been pointed out and evaluated by researchers through the outstanding applications of this method in education. Research highlights the potential of AI Chatbots to deliver personalized learning experiences. By analyzing user inputs and behaviors, chatbots adapt content delivery to individual learning styles and paces. Studies by El-Mourabit, Jai-Andaloussi, Ouchetto, and Miyara (2025) indicate that educational chatbots can adapt instructional content and feedback based on a learner's performance data which underlies their ability to personalize practice activities and that AI chatbots are effective at automating administrative tasks such as answering FAQs, providing scheduling information, and supporting course enrollment processes. A study by Smith, Jones, and Brown (2020) noted that universities deploying chatbots reported a significant reduction in administrative workload. One of the most significant advantages of AI chatbots is their availability. Learners can access educational support at any time, overcoming traditional temporal barriers. For instance, research by Lee, Crampton, and Tallarida (2019) found that students interacting with chatbots outside regular hours showed improved engagement and satisfaction.

AI chatbots have been particularly effective in language education. Platforms like Duolingo employ chatbot interactions to enhance conversational skills. Studies indicate that such tools provide a low-pressure environment conducive to practice and learning.

Effectiveness of AI chatbots in enhancing learning outcomes with: Research by Huang, Jiang, King, and Fryer (2025) indicates that students interacting with educational chatbots often report higher motivation and engagement factors correlated with better persistence and learning outcomes although direct evidence on increased course completion rates remains limited. A peer reviewed meta-analysis by Deng and Yu (2023) examined 32 empirical studies of chatbot assisted learning and compared outcomes with non-chatbot conditions. It found that chatbot use was associated with significantly improved knowledge retention compared with traditional conditions. Accessibility with chatbots provides equal opportunities for learners regardless of geographical or economic barriers, as evidenced in global studies on remote education.

Besides the benefits and effectiveness brought to education by AI Chatbots, there are also issues about challenges, opportunities and future directions in applying AI Chatbots in teaching. AI Chatbots may struggle with complex queries or contextual understanding, leading to user frustration. This issue was explored by Johnson (2020) who highlighted the need for more sophisticated NLP. Research reviewing chatbot based learning systems shows that educational AI chatbots often collect sensitive user data including personal details and interaction histories which raises significant privacy and security concerns. Experts emphasize the need for institutions to implement rigorous protocols for data collection, storage, and sharing to protect students' privacy. A survey of educational chatbot systems notes data privacy as a major concern and calls for strict data protection practices for chatbots collecting personal and performance data (Davar, Dewan, & Zhang, 2025). This limitation is a recurring theme in discussions about educational equity. Over-reliance on chatbots might reduce meaningful human interactions a concern raised by Park and Lee (2021). With future directions, the research identifies several areas for the advancement of AI chatbots in education: enhanced NLP capabilities, improving contextual and emotional understanding to make chatbots more intuitive. Integration with augmented reality (AR), combining chatbots with AR to create immersive learning experiences. Cultural adaptation, designing chatbots sensitive to diverse cultural and linguistic contexts. Ethical frameworks, establishing guidelines to address ethical concerns related to AI in education. Higher education

institutions, through pedagogy, should promote a holistic vision of student development that includes both academic and personal growth. The findings obtained from research can inform the design and implementation of programs and policies that promote a student-centered and holistic educational approach (Sánchez-Gómez, Cabanillas-García, & Verdugo-Castro, 2024).

Research on the use of AI Chatbots related to teaching has also been published, and the impact level in aspects of teaching activities has been indicated. AI Chatbots have been deployed in various educational contexts to facilitate student learning and support educators. They have emerged as transformative tools in education, offering innovative solutions to enhance teaching and learning. Their integration into classrooms and virtual learning environments has garnered significant attention from researchers. This literature review explores the current state of research on AI Chatbots in teaching, focusing on their applications, benefits, challenges, and implications for future pedagogy. Chatbots adapt to individual student needs, providing tailored feedback, learning resources, and assessment tasks. Research by Wollny et al. (2021) highlights how chatbots enhance engagement by delivering customized content based on students' progress. Administrative support, chatbots streamline administrative tasks, such as answering frequently asked questions, scheduling, and disseminating course information. Virtual tutors provide instant assistance with subject matter, enabling students to clarify doubts outside of traditional classroom hours. In language learning, studies by Duolingo and Rosetta Stone indicate that AI Chatbots effectively support language acquisition by simulating conversational practice and correcting errors in real-time. This study contributes to the understanding of the impact of synchronous real and virtual modes of teaching on students' presentation skills in the context of ESP and has practical implications for educators and course designers involved in ESP instruction. Incorporating a synchronous mode of teaching can be a valuable approach to developing students' presentation skills when combined with the integration of local Indonesian knowledge and diverse topics.

The integration of AI chatbots in teaching education offers numerous advantages. Chatbots provide support at any time of the week, ensuring that learning is not constrained by time or location; they can simultaneously assist large numbers of students, addressing issues of teacher workload; interactive and conversational interfaces foster a more engaging learning experience compared to static materials; chatbots collect and analyze student performance data, helping educators refine their teaching strategies (Chen, Chen, & Lin, 2020). Besides, AI chatbots face several challenges such as technical limitations, issues such as natural language understanding (NLU) errors and lack of contextual awareness that can hinder effective communication; privacy and data security remain critical issues, as chatbots require access to sensitive student information (Sharma, Tomar, Bhardwaj, & Sakalle, 2021); over-reliance on chatbots may reduce opportunities for human interaction and critical thinking development; developing more sophisticated algorithms to improve chatbot responsiveness and adaptability; establishing ethical frameworks and guidelines for data privacy and ethical use in educational settings; integrating chatbots with pedagogical models to investigate how they can complement traditional teaching methods and create hybrid learning environments; assessing the long-term impact of chatbot usage on student outcomes and teacher roles. Organizing teaching for students with the support of AI chatbots combines the advantages of direct classroom instruction with digital applications supported by AI chatbots, creating opportunities for students to experience both real and virtual learning environments (Giam, 2024).

AI, while proficient at managing information and facilitating personalized learning, cannot replicate the nuances of human interaction, such as body language, tone of voice, or emotional understanding. The overreliance on AI systems might result in a diminished emphasis on these human elements of communication and social interaction in an educational setting (Abbas, Jam, & Khan, 2024). Chatbots can be used to create more inclusive learning environments (Chen, Jensen, Albert, Gupta, & Lee, 2023). ChatGPT's and other AI chatbots' capabilities to process natural language input and generate human-like text make them potent tools for individualised education. They can engage in dialogues, answer a wide range of questions, and provide detailed explanations, thereby acting as virtual tutors available 24/7 for students (Hew, Huang, Du, & Jia, 2023; Limna, Kraiwanit, Jangjarat, Klayklung, &

Chocksathaporn, 2023). This immediate accessibility empowers learners to clarify doubts or understand complex concepts at their own pace without feeling time-pressured, as they might in traditional classroom settings.

AI chatbots hold significant promise for transforming education by enhancing accessibility, engagement, and personalization. While challenges persist, ongoing advancements in AI and a focus on ethical implementation can ensure that chatbots become integral tools in modern pedagogy. As research in this domain continues to evolve, a deeper understanding of their impact will help educators and institutions harness their full potential.

Table 1. The IT competence framework of students in teaching.

Component competence group	Index criteria
1-Understanding the competencies of IT application policy in teaching	1. Analyze, assessment issues of using IT in teaching. 2. Update and analyze trends and policies applying IT in teaching according to IT law. 3. Proposing alternatives for applying IT in the teaching process in accordance with objective and subjective conditions.
2-IT competences in the development of professional and occupational programs	1. Factors applying IT in professional and occupation programs. 2. Assess the impact of IT factors on training disciplines. 3. Demand for IT application in the development of professional and occupation programs.
3-IT competences associated with pedagogy	1. Identify IT competence factor in the teaching methodology. 2. Apply IT competence in teaching to develop career of yourself. 3. Competence in using IT in professional training and professional pedagogy of teachers. 4. Combine the application of IT with positive teaching methods and the specific teaching method of each specialty.
4-Computer operation competencies, using basic software, and IT equipment in teaching	1. Basic computer use and operation skills. 2. Ability to set up and use software and basic applications on the computer. 3. Skills to use basic IT application software in teaching. 4. Use peripherals and conventional IT tools in teaching.
5-IT competences in the design and construction of basic digital resources	1. Use the basic IT software and applications in designing, building digital resources. 2. Use tools to search, exploit, update, edit, and export documents for teaching. 3. Use utility software and IT support tools to exploit and manage digital resources in teaching.
6-Competences use specialized software to develop specialized expertise.	1. Ability to use specialized IT application software according to professional and industry characteristics. 2. Ability to integrate and embed IT application products in teaching. 3. Effectively manipulate products created from specialized software.
7-IT competencies organize deployment and assessment results	1. Use software to assist in the development, design, and management of test bank in digitized form. 2. Use a variety of forms of examination, assessment through tools, software to provide assessment information, feedback on teaching and learning. 3. Promoting the competence for IT application in the interactions of the process of organizing the examination, assessment, and feedback for students in the technology application environment.
8-IT competencies in the exploitation, use, and management of digital computer and internet resources.	1. Use tools to manage time, organize digital databases, and manage resources online. 2. Use tools to monitor, manage, communicate, and support students during the participation of the course. 3. Use proficient systems, external data storage devices, and online storage.
9-IT competencies are associated with technological equipment elements.	1. Use technology equipment and peripherals attached to computer systems and IT application systems. 2. Applying elements of technology equipment in a multi-dimensional interactive learning environment support design. 3. Capacity to use new technological equipment in teaching.
10-IT competences in the organization and administration of online courses	1. Ability to use and operate the course online. 2. Maximize the ability to administer and organize courses in an online environment. 3. The ability to analyze and access digital resources in the online environment. 4. Online work skills.

3. METHODS AND RESULTS

3.1. Methods

This research used mixed qualitative and quantitative methods for analysis and assessment. Qualitative methods are used to determine how to build a teaching model and assess learners' needs, and quantitative methods to create statistics and calculate empirical value indexes of the resulting teaching model based on the learning style (Almeida, 2020; Creswell, 2011). Due to the limited scope of the article, this section focuses solely on higher-level experiential learning, which includes experiences such as group discussions, practical experiments, and the immediate transfer of knowledge gained to others for a specific subject.

The research objectives are to investigate the effectiveness of AI chatbots in enhancing students' learning outcomes, assess how chatbots influence student engagement and motivation, and compare traditional teaching methods with AI chatbot-assisted teaching.

Define research subjects with target groups, including: Students: within a specific age and subject; Teachers: those who directly teach this subject and use AI Chatbots; and Experts: people who assess the criteria of the competence framework using AI Chatbots in teaching in secondary schools, high schools, and universities.

The survey data collected using the questionnaire was processed and analyzed by Microsoft Excel 2019 and IBM SPSS version 22 software to determine the necessity of using and developing AI chatbots in the teaching model.

The IT competence framework for pedagogical students includes a set of criteria to evaluate IT use competence, covering 10 competence components with 33 criteria indicators (Thanh, Thanh, & Tien, 2020).
Table 1 presents the IT competence framework for students in teaching, which includes the technology competencies used for integration with the AI chatbot model in this research experiment assessment.

This framework is further inherited and developed in the teaching model that incorporates AI chatbots, as demonstrated by the results of this study.

3.2. Results

AI Chatbot Scenario, Process of Using AI Chatbot in Teaching, and Self-learning Competence Matrix with the Support of AI Chatbot.

(1) Building a Teaching Process with AI Support

The teaching process with the support of AI may consist of three stages, as shown in Figure 1.

Figure 1. Teaching organization process with AI support.

Figure 1 presents the process of translating the theoretical foundations of teaching with AI support into practical teaching practices, making it easier for teachers to access and apply them in the organization and implementation of teaching.

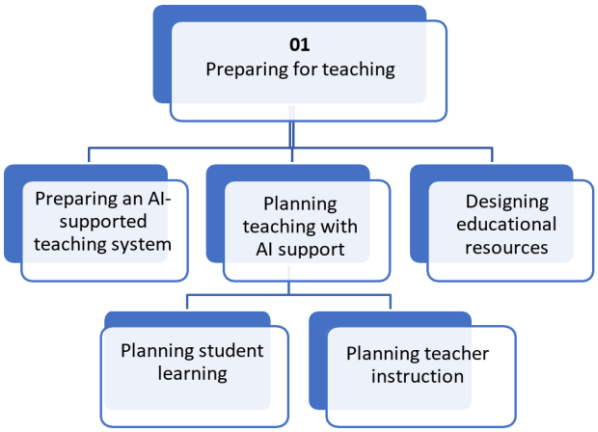

Figure 2. Tasks in the teaching preparation stage.

Figure 2 presents the details process of the Preparation of Teaching stage.

The teaching preparation stage includes three main steps:

Step 1: Preparation of AI-supported teaching system. In this step, in addition to preparing for direct classroom implementation using traditional methods, teachers need to prepare an integrated AI-supported teaching system. In this case, the author refers to a teaching support website with the address: www.bko.io.vn. The system needs to be fully updated with digital learning resources according to the curriculum for self-learning by students, and a topic-based assessment system to ensure effective teaching support deployment and achievement of set goals.

Step 2: Designing learning resources. For teaching with AI support, learning resources also play a crucial role and are an integral part of the teaching organization process. The learning resources mentioned in this article include study materials in the form of videos, text, a system of quizzes, and online multiple-choice tests.

Step 3: Planning AI-supported teaching. In principle, teaching with AI support essentially follows the direct teaching organization process as usual. However, the main difference is that teachers and students will use the AI-supported teaching system to implement teaching activities concurrently and complementarily with direct teaching. When planning teaching with AI support, teachers need to consider content allocation, classroom and self-learning duration for students, as well as selecting appropriate assessment methods in line with the teaching content and methods. In this step, it is essential to clarify the teacher's teaching plan and the students' learning plan:

Teacher's teaching plan: The plan specifies (1) the teaching content, (2) the teaching methods used, (3) the assessment methods (assessment tools used with AI support).

Student's learning plan: Establishing students' learning plans to ensure the completion of the curriculum and achievement of learning outcomes. In this article, learning materials include videos, text, a system of quizzes, and online multiple-choice tests.

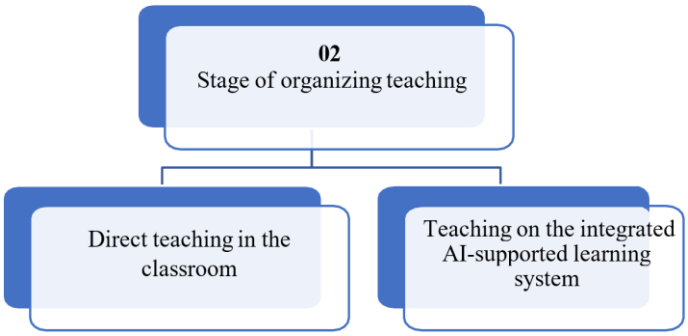

Figure 3. Tasks in the teaching organization stage.

Figure 3 presents the process of the Organizing Teaching stage.

The teaching organization stage includes two activities deployed concurrently or alternately, namely:

Direct classroom teaching: Teaching in the classroom will be carried out according to traditional methods with steps such as class stabilization/warm-up; reviewing previous lessons and preparing for new lessons by students; delivering new teaching content combined with discussion/individual exercises/group exercises; reinforcing knowledge, assigning homework to students (including learning content on the AI-supported teaching system mentioned above).

Teaching on the AI-supported teaching system: Alongside direct classroom teaching, teaching content on the AI-supported teaching system is an important, meaningful step in organizing teaching according to the proposed method. The system will support "personalized" student learning through specific proposals, recommendations:

For teachers: Based on the teaching plan established during the teaching preparation stage (part a above), teachers will make requests to students regarding self-learning content, exercises, or tests that need to be completed.

For students: Students will carry out self-learning content according to the schedule/plan provided by the teacher or actively engage in their own learning. The AI support in this system is reflected in recommended content during and after students complete assessment tests. Recommended content includes groups of questions with knowledge equivalent to the wrong answers students have given... and corresponding learning support materials. Learning on the system with AI support can be performed multiple times to ensure students reinforce their knowledge by repeating test questions or actively relearning/pre-learning materials provided on the system.

Testing, Evaluation, and Adjustment Stage:

After conducting teaching, teachers evaluate whether the teaching process has achieved the learning outcomes or goals set by the teaching plan. From the strengths and weaknesses in the teaching process, adjustments are made, improvements are implemented, and lessons are learned for future teaching in the Figure 4:

Evaluation in the classroom: Teachers select appropriate evaluation methods based on the classroom learning content with assessment methods similar to those in traditional teaching methods (at the end of each lesson, at the end of a chapter, or group of related lessons in the form of large exercises...).

Evaluation of the AI-supported teaching system: The teaching process with AI support (via the website) occurs concurrently with classroom instruction, allowing teachers to design assessments for students to complete independently. The AI support is demonstrated by providing suggestions and hints during the students' test-taking process.

Learning from experience, adjusting, and refining: During the teaching process, feedback from learners (through post-class evaluations), from the system (through suggestions for students ensuring diversity in learning resources, system-generated reports as requested by users) forms the basis for teachers to adjust and refine their teaching plans. Similarly, students can rely on learning outcomes (through test results, system evaluations) to adjust their learning trajectories (or follow the system's proposed trajectory).

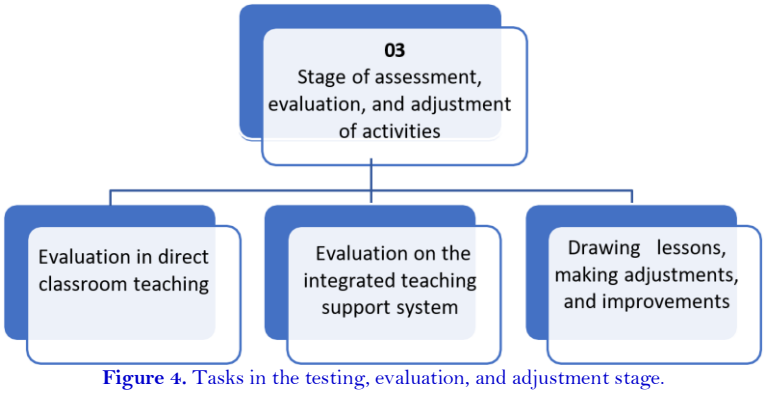

Figure 4. Tasks in the testing, evaluation, and adjustment stage.

(2) Building Process of AI Chatbot Scenario in Chemistry Education

Objective of Building AI Chatbot Scenario:

The AI chatbot scenario is the "soul" of the bot, determining its intelligence and effectiveness in supporting chemistry education.

The goal of building the AI Chatbot scenario is to help students develop self-learning competencies through activities:

Constructing theoretical knowledge from basic to advanced levels according to the content and program structure.

Creating lecture videos for self-study enables students to extract basic knowledge and skills independently. Based on this foundational knowledge, students can interact with the Bot to "update" advanced knowledge.

Developing exercises from qualitative to quantitative, from easy to difficult levels, to foster problem-solving skills for students.

Principles of Building AI Chatbot Scenario:

To build an intelligent AI Chatbot, the scenario-building process must adhere to strict principles. Based on the direction of content development and educational goals in chemistry education, the AI Chatbot scenario is built upon the following principles:

Principle 1: Ensure educational objectives

The teaching scenario must clearly define the learning objectives that learners need to achieve, following the knowledge standards specified in the chemistry education curriculum.

Principle 2: Ensure content and scientific rigor

The knowledge system must be closely related to the content and objectives of chemistry education. Along with ensuring scientific rigor, the AI Chatbot scenario must be engaging, attractive, easy to operate and use, providing learners with genuine scientific knowledge and enhancing their self-learning abilities.

Principle 3: Ensure pedagogical aspects

This principle requires that the AI Chatbot scenario be logically structured, clear, suitable for students' cognitive levels, and promote positive, proactive, and creative engagement in students' self-learning processes.

Principle 4: Ensure feasibility

The AI Chatbot should be widely applicable, easy to use, compatible with common smartphone operating systems such as Android, iOS, Windows Phone, and compatible with popular social media platforms such as Zalo and Facebook. It should be easy to install and use, especially in developing students' self-learning abilities when studying with the virtual teacher - AI Chatbot.

Principle 5: Ensure aesthetic quality

The content, knowledge, design, and construction of chemistry education teaching materials need to be harmonious, with appropriate colors suitable for the psychological state of students. Additionally, the AI Chatbot must have a clear and understandable structure, facilitating students' quick and effective learning, querying, and interaction.

Process of Building AI Chatbot Scenario:

Based on the characteristics of chemistry education and the benefits of AI Chatbots, the author finds that integrating AI Chatbot scenarios in education is highly suitable for achieving teaching objectives, enhancing teaching effectiveness, and developing students' self-learning abilities. The process of building AI Chatbot scenarios in education is proposed in the following steps:

Figure 5 illustrates the flowchart of the AI chatbot scenario-building process in education.

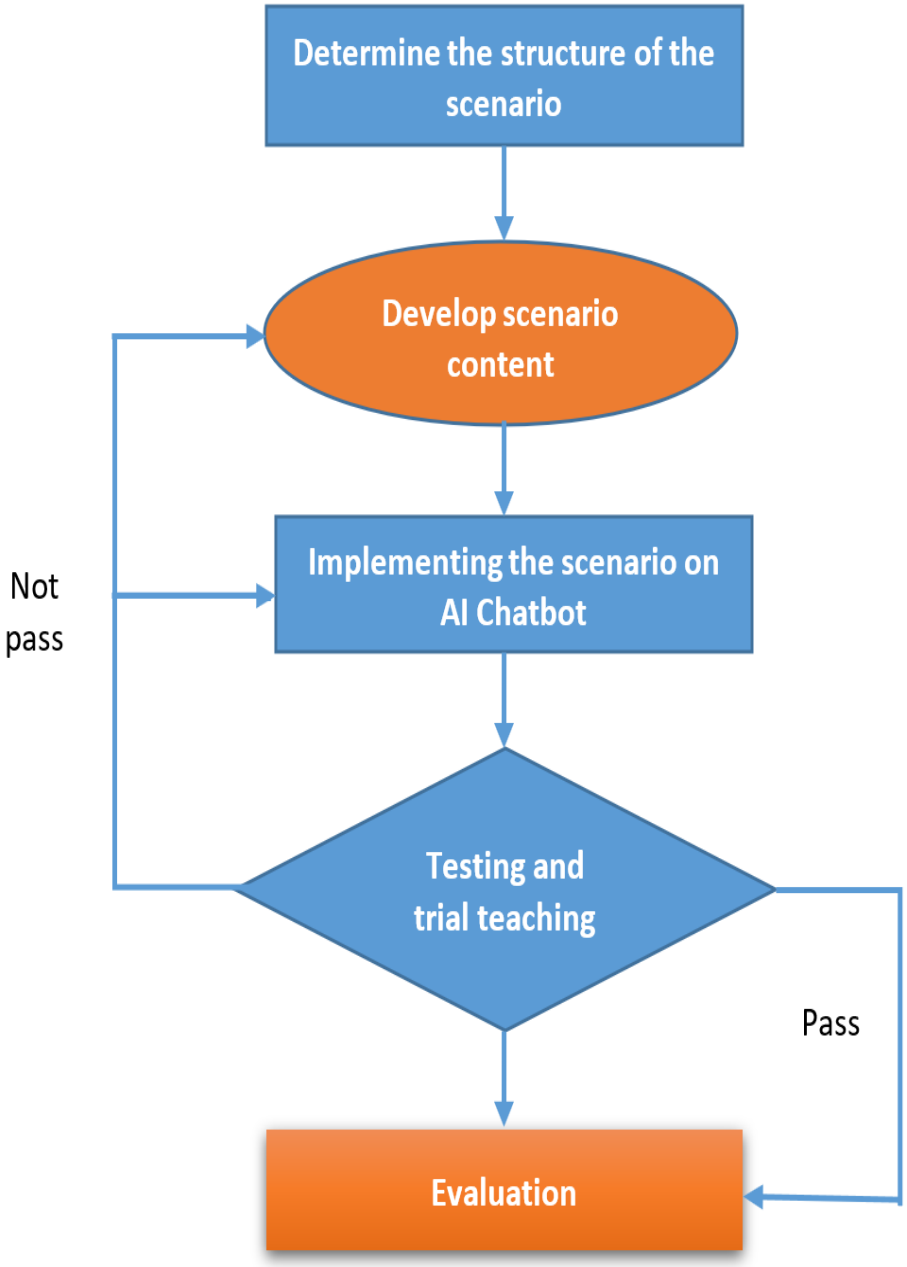

Figure 5. Process of building AI chatbot scenario in education.

Step 1: Determine the structure of the scenario

Define the learning objectives of education.

Prepare and select relevant resources for the lessons in the curriculum.

Design prompts, situational questions, interactive questions, test exercises, and teaching-learning-evaluation-feedback strategies.

Structure the education scenario towards personalized learning:

Select an AI chatbot: FPT.AI is equipped with machine learning and natural language processing technology in Vietnamese. FPT.AI Chat can understand users' intentions, provide appropriate answers, and become smarter over time. In this platform, the AI Chatbot is created as a course, and the teacher has full control over the teaching content and the learning process of students.

Step 2: Develop scenario content

Developing scenarios for the education program based on the amount of knowledge, from basic to advanced levels, to serve the needs of each student and personalize learning. Students in subsequent classes can review previous

class knowledge and foundational concepts at any time via the AI Chatbot. Proficient students can supplement their learning with advanced, in-depth knowledge independently.

Natural Language Processing - NLP is a core AI feature of the FPT.AI Conversation platform. To enable the bot to understand students' statements, teachers designing the bot need to teach it specific knowledge according to each lesson content of the subject. In FPT.AI, a scenario is a topic that the bot relies on to answer students. A step is a sub-topic.

A scenario consists of multiple steps with the same theme. These steps can be interconnected by nodes.

Designing response scenarios according to each intention. For intentions where the sample sentence does not contain entities, the bot only needs to provide one answer. However, for intentions where the sample sentence contains object entities, the bot needs to provide different answers based on that entity.

Step 3: Implementing the scenario on the AI Chatbot system

To create and deploy a new scenario, follow these steps:

1. **Create a scenario**
    - Go to the **Add Scenario** menu.
    - Enter the scenario name.
    - Click **Create** to generate the scenario.
2. **Create a step**
    - Enter the step name (lesson name).
    - Click **Create** to add steps within the scenario.

Once you complete these two steps, the new scenario will be successfully created and ready for use.

Step 4: Testing and trial teaching

Test the intelligence of the bot by asking random questions and checking the accuracy of the bot's responses. Check for errors and troubleshoot from digitization to the final step of implementing the teaching scenario on the bot until the accuracy reaches 100%. Then proceed to trial teaching.

Repeated trial teaching before official teaching to identify errors for adjustment and accumulation, supplement new knowledge for the AI chatbot to become smarter over time.

Step 5: Evaluation

Evaluate the quality and effectiveness of education and teaching using the AI chatbot by achieving the learning objectives of education, thereby improving the scenario, adjusting, and enhancing the quality and effectiveness of teaching to develop students' self-learning abilities.

With the process of building teaching scenarios for this Engineering AI Chatbot, educators or educational institutions can develop these AI Chatbot teaching scenarios for other subjects to create a virtual teacher AI Chatbot, supporting the teaching process according to the purposes of the builder to personalize learning for students, where the teacher only guides and supports students' self-learning. This process creates a personalized learning environment and develops self-learning capabilities.

Process of Using AI Chatbot in Chemistry Education:

Once the teaching scenario is in place, meaning there is a product like the AI Chatbot - "Bach Khoa Chemistry Teacher," teachers rely on the following process (Figure 6) to use it in the chemistry teaching process to develop self-learning abilities for students (Giam, 2024):

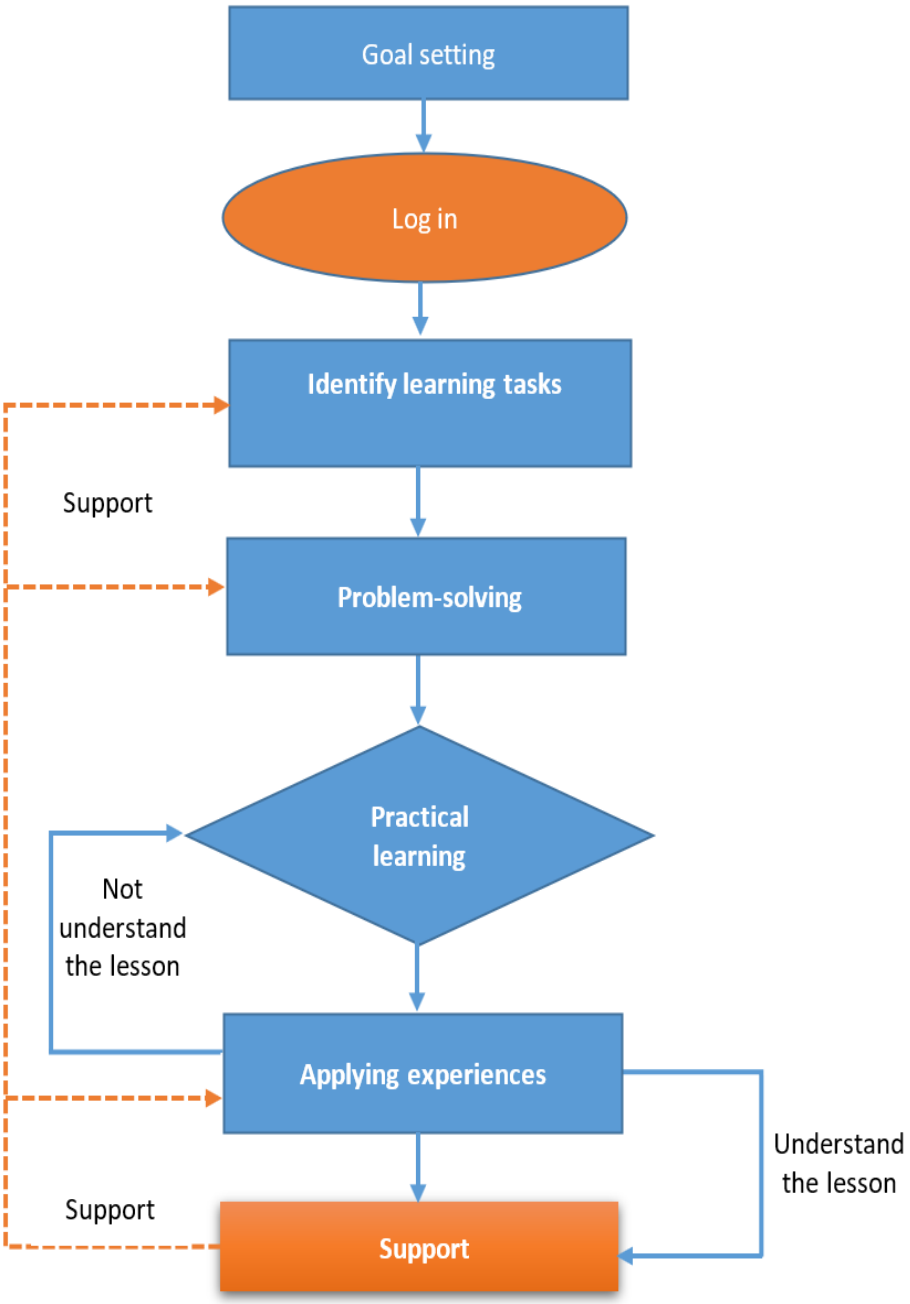

Figure 6. Process of using AI chatbot in chemistry education.

This process helps develop students' self-learning abilities and reduces pressure on teachers during the teaching process. The AI Chatbot is directed and controlled by subject matter experts, ensuring accurate and comprehensive responses.

Building a self-learning competence framework with the support of AI chatbot.

The proposal is a self-learning competence framework in one of the subjects (Chemistry Education) with the support of an AI Chatbot, as depicted in Figure 7.

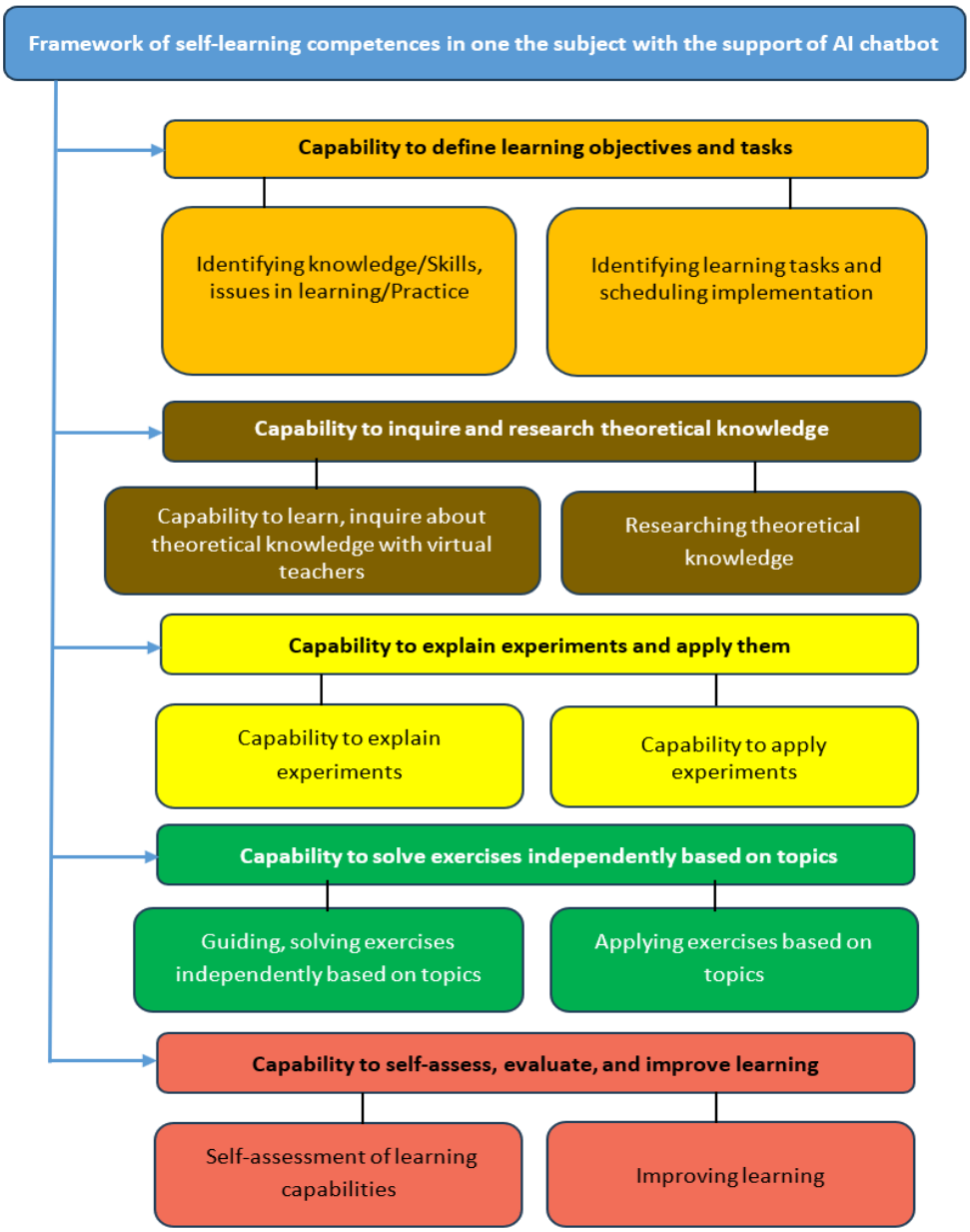

Figure 7. Structure diagram of the self-learning competence framework in one subject with the support of AI chatbot.

The self-learning competence framework in one of the subjects with the support of AI chatbot, as shown in Figure 7, consists of 5 competencies and 10 criteria built on the basis of 3 basic competencies.

The framework of self-learning competencies in chemistry education with the support of AI Chatbot:

Planning self-study competence is the ability of learners to identify learning objectives and tasks, study content, plan, and organize time, resources, and methods to achieve those objectives.

Implementing Self-Study competence is the ability to search, research, inquire about information sources, analyze, process information, and apply knowledge and skills to solve learning objectives and tasks.

Evaluating outcomes, adjusting self-learning processes, and improving learning are the abilities to analyze, compare, and contrast the self-learning process with completed learning objectives and tasks to self-assess and adjust the self-learning process to improve and enhance the effectiveness of self-learning activities.

To develop self-learning competencies for students, it is necessary to encourage students to independently plan and conduct research. Self-learning competence is demonstrated through students' ability to self-reflect, self-assess, and self-criticize. An AI Chatbot can be used in education as a teaching support tool to help students develop self-

learning competencies. The process of organizing teaching with the support of an AI Chatbot includes three stages: pre-class use, in-class use, and post-class use.

Pre-class use: Students self-study and research basic knowledge content, foundational knowledge through interaction with the Bot. Students observe experimental content and study chemical problems to prepare for classroom lessons.

In-class use: Teachers guide students to use AI Chatbot for self-learning and interaction with the Bot. Teachers support monitoring students' learning progress and summarize the main content of the lesson.

Post-class use: Students review and reinforce knowledge after classroom lessons, as well as independently research and explore new knowledge with the support of AI Chatbot. Through these stages, students are encouraged to develop self-learning competencies through self-study, research, and self-assessment.

Testing and Evaluating the Feasibility and Effectiveness of the Scientific Hypothesis on the Use of AI Chatbot.

(1) Research Methodology

Purpose of testing and evaluating the feasibility and effectiveness of the scientific hypothesis: The proposed AI chatbot scenario and subject-specific Chemistry teaching process, supported by the AI chatbot, are deemed appropriate for the self-learning competence framework and the structured content of Chemistry aimed at developing self-learning competencies.

(2) Expert Method Design

(1) Expert Components

The study selected 43 experts, including: Education, Theory and Teaching Methods (16 members are PhDs, Associate Professors, Professors at Pedagogical Institutes and Universities), Pedagogy of Chemistry (27 members are Chemistry teachers at secondary schools and high schools) in the northern and southern provinces of Vietnam to solicit opinions. The timeframe was from May 2023. (Appendix 1. List of experts).

(2) Evaluation Content

Expert opinions included key content of the paper, comprising: a general description of the theoretical basis of teaching for developing self-learning competencies in chemistry. A description of the self-learning competence framework in chemistry for secondary school students with the support of AI Chatbot.

Lesson design: Chemical properties of metals with the support of "Bach Khoa Chemistry" AI chatbot to develop self-learning competencies in chemistry for secondary school and high school students.

(3) Methods and Techniques

After completing and sending the survey draft, assessing the self-learning competence components and teaching design in chemistry with the support of AI Chatbot to experts, the authors conducted in-depth interviews with experts regarding the completeness of the self-learning competency scale in the survey, to subsequently adjust and improve the survey and expert evaluation.

Expert opinion surveys were conducted in the form of a questionnaire on the necessity and feasibility of AI Chatbot through the lesson teaching process: Chemical properties of metals with the support of Bach Khoa Chemistry AI Chatbot (on the website browser: http://bko.io.vn) to develop self-learning competencies in chemistry for secondary school students. The evaluation of self-learning competencies includes three competence components with 15 criteria detailed in Table 2, and the teaching design in chemistry with the support of AI Chatbot was reviewed by experts through opinion surveys via paper and online forms. Each criterion for competence was assessed on three levels: *Not at all*, *Partially, and Fully*. Expert opinion surveys were requested to include names, phone numbers, and emails to both collect data and facilitate further discussion on evaluation information when necessary (Appendix 2. Expert opinion board).

A video of the teaching process experience using AI Chatbot for the Chemical properties of metals lesson was sent to experts, and phone communication was used to exchange information with distant experts whom the author

couldn't meet in person. For experts met in person, the author introduced and directly experienced the teaching process using Bach Khoa Chemistry AI Chatbot on the expert's phone or computer.

(3) Evaluation and experimental results

The results obtained from expert opinion surveys are presented in Table 2 as follows:

Table 2. Results of evaluating self-learning competence components and teaching design in Chemistry with the support of AI chatbot.

Component/Capability Criteria	Levels		
	Not at all	Partially	Fully
Capability 1. Capability to determine learning objectives and tasks of learners (from 1 to 5)			
Criterion 1. The learning process with a chatbot helps learners identify the knowledge and skills related to the chemical properties of metals lesson at the specified level.	0	9	34
Criterion 2. The learning process with a chatbot helps learners identify how to assess and evaluate learning outcomes of the chemical properties of metals lesson at the level.	0	7	36
Criterion 3. The learning process with a chatbot helps learners identify issues related to the chemical properties of metals lesson at the appropriate level.	0	6	37
Criterion 4. The learning process with chatbot helps learners identify the learning tasks of the chemical properties of metals lesson at the level.	0	8	35
Criterion 5. The learning process with a chatbot helps learners schedule study time to implement self-learning of the chemical properties of metals lesson at the level.	0	10	33
Capability 2. Capability to be active in the learning process of learners (from 6 to 10)			
Criterion 1. The learning process with a chatbot allows learners to look up terms, concepts, knowledge units, and the relationships between knowledge units in the lesson necessary for them at the level.	0	6	37
Criterion 2. The learning process with a chatbot allows learners to experiment and correct mistakes when self-learning at the level.	0	16	27
Criterion 3. The learning process with a chatbot helps learners explain the nature of chemical phenomena in experimental videos used in the lesson on the chemical properties of metals at the specified level.	0	11	32
Criterion 4. The learning process with a chatbot helps learners identify chemical knowledge for practical problems related to the content of the chemical properties of metals lesson at the level.	0	7	36
Criterion 5. The learning process with a chatbot helps learners identify chemical knowledge to solve situations and learning tasks in the Chemical Properties of Metals lesson at the specified level.	0	7	36
Capability 3. Capability to improve the learning efficiency of learners (from 11 to 15)			
Criterion 1. The learning process with a chatbot introduces learners to various exercises in the chemical properties of metals lesson at the level.	1	9	33
Criterion 2. The learning process with a chatbot introduces learners to how to solve model exercises in the chemical properties of metals lesson at the level.	0	12	31
Criterion 3. The learning process with a chatbot provides learners with multiple-choice questions to practice their knowledge of the chemical properties of metals lesson at the specified level.	0	12	31
Criterion 4. The learning process with a chatbot provides learners with a learning history, enabling them to search for and correct mistakes, identify limitations, and adjust their learning methods to meet the requirements in the chemical properties of metals lesson at the appropriate level.	0	9	34
Criterion 5. The learning process with a chatbot provides learners with measures to address mistakes, limitations, and adjust learning methods to suit the requirements in the chemical properties of metals lesson at the level.	0	10	33

The charts describe the learners' capability to determine their own learning (Figure 8), their ability to be active in the learning process (Figure 9), and their capability to improve learning efficiency (Figure 10). These figures

illustrate the evaluation results of self-learning competence components and teaching design in a subject supported by an AI chatbot (detailed criteria are shown in Table 2).

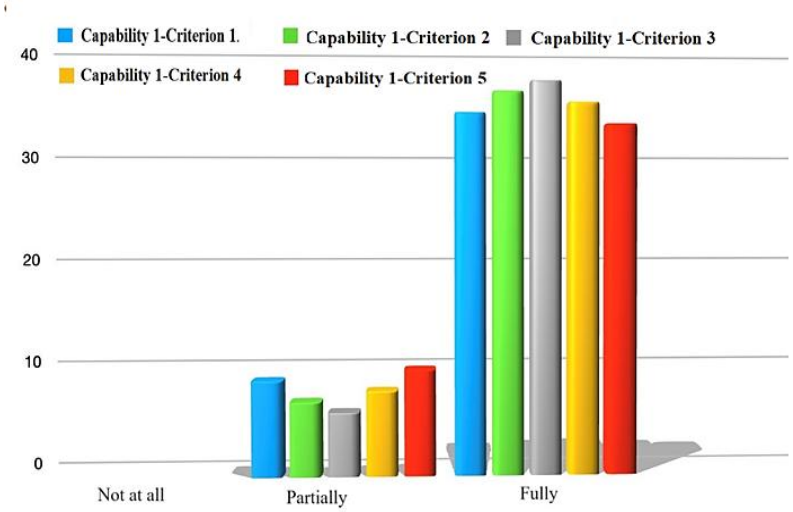

Figure 8. The capability to determine learning objectives and tasks of learners.

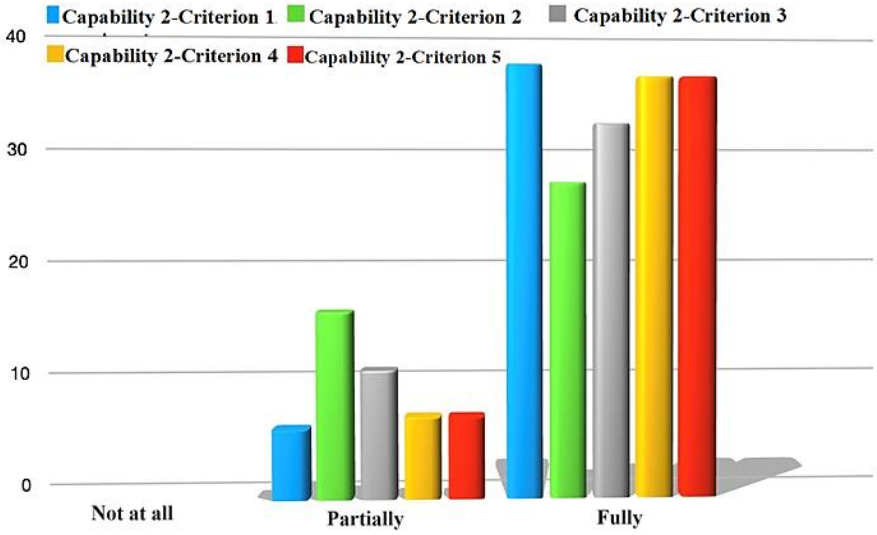

Figure 9. The capability to be active in the learning process of learners.

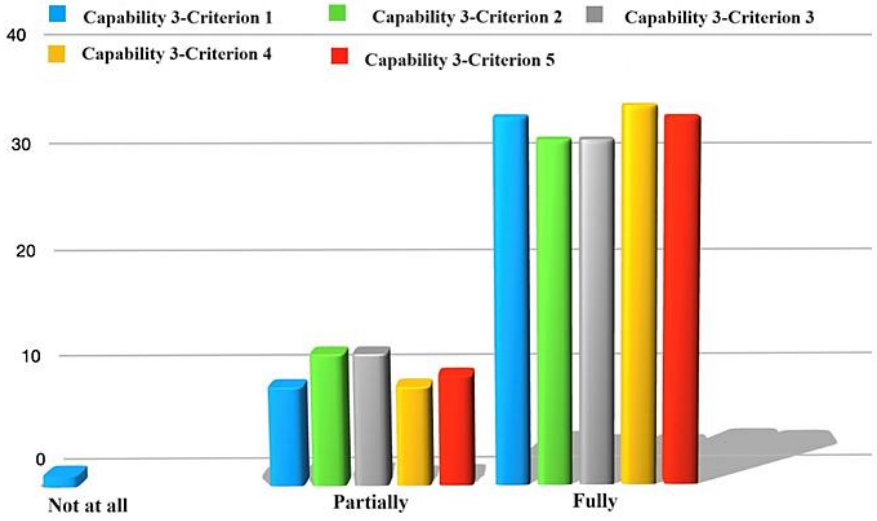

Figure 10. Capability to improve the learning efficiency of learners.

The results obtained from the expert method indicate that the majority of experts agree with the components of the self-learning competence framework in chemistry with the support of AI Chatbot at the level of Fully, accounting for 70% - 75%, and at the level of Partially, accounting for 18% - 25% across all three competency elements. However, in the competence components of Improving Learner Effectiveness, one expert rated it as Not at all in the criterion of Learning process with Chatbot introducing exercises in the Chemical properties of metals lesson. According to the author's objective assessment, this expert might not have fully experienced the lesson during the evaluation process. Experts rated Partially due to the large dataset required for the AI Chatbot to be fully perfected, which necessitates time and user interaction for the Bot to learn additional knowledge content. The knowledge content on the Bot serves as a representative of the main content but may not be fully detailed to meet the experiential and evaluative requirements of users. The competence framework, along with the criteria for assessing competencies, is comprehensive, ensuring accuracy, feasibility, and effectiveness in developing self-learning competencies in chemistry with the support of AI Chatbot.

Alongside expert evaluations of the self-learning competence framework in Chemistry with AI Chatbot support, the author also received invaluable advisory opinions from experts, such as setting up an Index section in the Bot for easier keyword searches. The author earnestly listened to, absorbed, and amended, adding the Index section to the Bot to continually enhance its intelligence, completeness, and scientific rigor to meet learners' needs.

Experiment - Regular Assessment.

Conduct experiments and evaluate the impact of the AI chatbot teaching model integrated with the IT competence framework for student learning.

Table 3 presents the number of students by gender in classes conducting experimental assessments.

Table 3. Information on the experimental class (EC) and control class (CC).

Sex	Male	Female	Total
EC	23	17	40
CC	21	19	40

Table 4. Paired sample test in the experimental (A) and control (B) groups.

Test		Mean	N	Std. Deviation	Std. Error Mean
Test 1	Group A	7.213	40	1.6237	0.2614
	Group B	6.997	40	1.7412	0.2775

Table 5 presents the results of both experimental and control classes.

Table 5. Paired samples test of (A) and (B) groups.

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
					Lower	Upper			
Pair 1	Group A - Group B	0.1875	0.4339	0.0686	0.0487	0.3263	2.733	39	0.008 > 0.005

Before the experiment, both groups took Test 1, with the results obtained in Table 4. The reliability of the results of the first test, Sig. (2-tailed) = 0.008, which is greater than 0.05, indicates that the results of both the experimental and control groups are similar (Table 5).

After the experiment: Both EC and CC classes performed four tests together, including three formative assessments (test 2, test 3, test 4). The results obtained are as follows:

Table 6 and Table 7 present the correlation analysis parameters of the results of three test rounds with the experimental and control classes.

Table 6. Mean and standard deviation between EC and CC classes.

	EC2	CC2	EC3	CC3	EC4	CC4
Mean	7.0875	6.7125	7.2750	6.9750	7.5625	6.9125
N	40	40	40	40	40	40
Std. Deviation	1.72049	1.62073	1.16548	1.40945	1.27192	1.48879

Table 7. Paired differences: three tests between EC and CC.

Group		Paired differences					t	P-Value	df
		Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
					Lower	Upper			
Test 2	EC2 – CC2	0.37500	0.41986	0.06639	0.24072	0.50928	5.649	0.000	40
Test 3	EC3 – CC3	0.30000	0.49094	0.07763	0.14299	0.45701	3.865	0.000	40
Test 4	EC4 – CC4	0.65500	0.49614	0.07845	0.49133	0.80867	8.286	0.000	40

- After the experiment with test 2, the mean score difference between the EC and CC is 0.37500. The p-value is less than 0.05, indicating that the study's impact is statistically significant in helping students improve their academic performance. Although the difference in mean values between the CC and EC has changed, the independent t-test results show $p = 0.000$ ($p < 0.05$), confirming the significance of the difference. However, this difference is small, suggesting that the increase in mean values for both CC and EC is likely due to random variation. The effect size calculation yields a t-value of 5.649, which falls within the average range, indicating a moderate effect. Overall, the difference between the two groups is statistically significant, supporting the effectiveness of the intervention.
- The difference in mean value and the effect size between the EC and CC in test 3 is 0.30000. With the independent T-test results of the EC and CC being 0.000 ($p < 0.05$), the difference between the mean value of this group after EC is significant, not due to random probability but rather due to the effectiveness of measures using AI chatbot. Using the formula to calculate the effect size between the two groups, the result is $t = 3.865$; the effect size is small. This means that the effect of teachers' intervention on the mean difference is small. However, that disparity is meaningful, practical, and believable.
- With test4, the independent T-test of the EC and CC being 0.000 ($p < 0.05$), the difference between the mean value of this group after EC is significant, not due to random probability but rather by the effect of the teachers' intervention. The difference between the EC and CC after the experiment is that the mean is 0.65500, and the t-value of 8.286 is quite large. This indicates that the effect of teachers' intervention on the mean difference is substantial, making the difference statistically significant, practically meaningful, and reliable.

Comment: AI chatbots have the potential to significantly enhance the evaluation of students' IT competence by providing personalized, real-time support. Regular AI-driven assessments can promote a deeper understanding of IT concepts and improve student performance, though adequate infrastructure and training remain essential.

4. DISCUSSION AND CONCLUSIONS

AI chatbots can enhance the assessment of students' IT competence by adapting to their individual learning needs and pace. They can identify areas where students struggle and offer targeted resources or explanations, ensuring a more personalized and effective evaluation process. AI chatbots can provide immediate feedback on assignments, quizzes, and other assessments. This prompt response helps students understand their mistakes and correct them in

real-time, reinforcing learning and reducing the likelihood of misconceptions persisting. Interactive AI chatbots can make learning more engaging. By using conversational interfaces, chatbots can simulate a tutoring experience, making learning feel more interactive and less intimidating. Gamification elements, such as quizzes or challenges, can also be incorporated to motivate students. While AI chatbots offer numerous benefits, there are also ethical considerations to keep in mind. Privacy concerns, data security, and the potential for over-reliance on technology are important issues. Additionally, the quality of the AI's responses and its ability to understand nuanced questions or provide accurate information must be closely monitored. The development of students' creative competency will help students participate and self-assess learning outcomes. The development of technology and its role in the inversion classroom model to promote and the growth of online learning environments should be enhanced (Thanh et al., 2020). The blended teaching model developing self-study competency for students and teachers will be a professional, practical, and meaningful document to make teaching and learning activities more effective. It also confirms the satisfaction of students with teachers using this model in online teaching to help students improve their learning performance as well as their learning results (Thanh et al., 2021; Thanh et al., 2020). Chatbots rely on pre-programmed responses or machine learning models, which may not always provide accurate or contextually appropriate answers. Misleading or incorrect information can negatively impact learning outcomes. Studies demonstrate that chatbots can provide real-time feedback and guidance to learners, fostering a more responsive and tailored learning environment (Holmes, Bialik, & Fadel, 2019). AI chatbots can tailor educational content to meet individual student needs. They analyze student performance data and provide targeted feedback, helping learners address their weaknesses and build on their strengths. For instance, platforms like Duolingo use AI chatbots to adapt language lessons based on user progress (Von, 2020). AI chatbots have significant potential to transform education. However, successful integration requires addressing challenges and leveraging them as complementary tools to enhance human-led teaching and learning. Recent studies indicate that AI chatbots enhance learning by providing immediate feedback, personalized explanations, and on-demand academic support, particularly in technology-related learning contexts. Evidence from higher education shows that students perceive chatbots as effective in clarifying complex concepts, supporting independent problem solving, and improving learning efficiency—skills that are closely associated with the development of information technology competence. Moreover, systematic reviews suggest that chatbot-supported learning environments positively influence student engagement, motivation, and satisfaction when integrated into well-designed instructional frameworks (Kuhail, Alturki, Alramlawi, & Alhejori, 2023).

The paper presents the process of constructing a teaching scenario that applies an AI chatbot and the process of using the AI chatbot in teaching for one subject. Both processes focus on utilizing the AI chatbot to create a personalized learning environment and develop students' self-learning competencies. A framework for self-learning competencies in teaching a subject with AI chatbot support is proposed. It consists of five competence components and ten criteria, based on three fundamental competencies inherited from the IT competence framework for students in teaching and online teaching. Through these stages, students are encouraged to develop self-learning competencies through self-study, research, and self-assessment. The AI Chatbot is used as a teaching support tool to help students develop self-learning competencies. This research results, based on expert opinions, show that the majority agree with the components of the self-learning competency framework in teaching for one subject with AI Chatbot support, with a completeness rate averaging 70% - 75%. However, there are still incomplete parts that need improvement, especially in providing data and user interaction to enhance the completeness of the Chatbot. Furthermore, expert opinions have significantly contributed to the development of future research. Suggestions, such as setting up an index section in the bot for easier keyword searches, have been accepted and implemented to improve the quality and effectiveness of the chatbot. In summary, our research highlights the importance of using AI technology, specifically AI Chatbots, in education to support the development of students' self-learning competencies. Despite limitations and challenges, the potential of this research is vast and needs to be further explored and developed in the future to enhance the quality of education. Using AI Chatbots in education has the potential to significantly enhance students'

IT and self-learning competencies. By providing personalized, accessible, and engaging learning experiences, AI Chatbots can help students take greater ownership of their education, fostering a lifelong love of learning. However, it is crucial to address the ethical considerations and challenges associated with this technology to ensure its responsible and effective implementation.

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Institutional Review Board Statement: The Ethical Committee of the Faculty of Educational Science and Technology, Hanoi University of Science and Technology, Vietnam has granted approval for this study on 21 June 2024 (Ref. No. 4209/QĐ-ĐHBK).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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APPENDIX 1. List of experts participating in the evaluation. (Schools in Vietnam).

1. Associate Professor Dr. Nguyen Van Tuan, Ho Chi Minh City University of Technical Education Expert
2. Dr. Phan Long, Ho Chi Minh City University of Technical Education Expert
3. Teacher Nguyen Thi Ngoc Ha, Linh Dong Secondary School Expert
4. Associate Professor Dr. Vo Thi Ngoc Lan, Ho Chi Minh City University of Technical Education Expert
5. Teacher Nguyen Thanh Ton, Duong Van Thi Secondary School Expert
6. Teacher Nguyen Thi Thu Huong, Phu Tho Province Ethnic Minority Boarding School Expert
7. Teacher Tran Thi Minh Ngoc, Ngo Chi Quoc Secondary School Expert
8. Teacher Nghiem Xuan Vuong, Edison Schools High School Expert
9. Teacher Tran Thi Ngoc Dung, Le Van Viet Secondary School Expert
10. Teacher Pham Thi Thanh Huyen, Phu Tho Province Ethnic Minority Boarding School Expert
11. Dr. Truong Minh Tri, Ho Chi Minh City University of Technical Education Expert
12. Teacher Do Thi Thu Thuy, Cu Chinh Lan Secondary School Expert
13. Associate Professor Dr. Nguyen Van Hanh, Hanoi University of Science and Technology Expert
14. Lecturer Nguyen Thi Thuong Thuong, Phuong Xa High School Expert
15. Associate Professor Dr. Tran Khanh Duc, Hanoi University of Science and Technology Expert
16. Lecturer Hoang Thi Thanh Hai, Luong Dinh Cua Secondary School Expert
17. Lecturer Nguyen Ngoc Loan, Tam Binh Secondary School Expert
18. Master Nguyen Thi Hoai Nam, Hanoi University of Science and Technology Expert
19. Lecturer Nguyen Thi Kim Cuc, Tien Luong Secondary School Expert
20. Master Nguyen Van Doc, Hanoi University of Science and Technology Expert
21. Lecturer Ha Xuan Binh, Ngo Xa Secondary School Expert
22. Dr. Vuong Van Cho, Van Lang University Expert
23. Lecturer Le Thi Kim Dung, Phu Tho Ethnic Minority Boarding School Expert
24. Lecturer Do Phuong Tuan, Phuong Xa High School Expert

25. Lecturer Nguyen Trong Thu, Phuong Xa High School Expert
26. Lecturer Nguyen Truong Tan, Phu Tho Ethnic Minority Boarding School Expert
27. Dr. Nguyen Toan, Ho Chi Minh City University of Technology Expert
28. Lecturer Cao Thien Phuc, Trinh Hoai Duc Secondary School Expert
29. Master Nguyen Dang Tien, Trinh Hoai Duc Secondary School Expert
30. Lecturer Duong Thuy Nga, Trinh Hoai Duc Secondary School Expert
31. Lecturer Nguyen Thi Nghia, Trinh Hoai Duc Secondary School Expert
32. Lecturer Vo Dinh Toan, Trinh Hoai Duc Secondary School Expert
33. Lecturer Truong Le Ngoc, Trinh Hoai Duc Secondary School Expert
34. Dr. Truong Viet Khanh Trang, Saigon University Expert
35. Lecturer Nguyen Thi Hong Nhung, Trinh Hoai Duc Secondary School Expert
36. Lecturer Nguyen Thi Anh Tuyet, Trinh Hoai Duc Secondary School Expert
37. Lecturer Le Khac Tuan, Hanoi University of Theatre and Cinema Expert
38. Dr. Tran Tuyen, Ho Chi Minh City University of Technical Education Expert
39. Dr. Nguyen Ngoc Phuong, Ho Chi Minh City University of Technical Education Expert
40. Dr. Tran Thi My Duyen, Van Lang University Expert
41. Dr. Nguyen Thi Huong Giang, Hanoi University of Science and Technology Expert
42. Assoc. Prof. Dr. Ngo Tu Thanh, Hanoi University of Science and Technology Expert
43. Prof. Dr. Nguyen Xuan Lac, Hanoi University of Science and Technology Expert

APPENDIX 2. Expert opinion request form.

In order to evaluate students' ability to self-study chemistry with the support of an AI chatbot in teaching, we invite teachers to review the Pedagogical Script for Designing Chemistry Lessons for Grade 9, specifically the lesson on *Chemical Properties of Metals*.

We kindly ask teachers to provide their assessment of students' ability to develop self-study skills when learning with the AI chatbot. Your feedback will be used solely for scientific research purposes and not for any other purpose.

Part 1: Assessing the ability to develop the capacity to identify learning goals and tasks of learners (from 1 to 5)

1. The learning process with the chatbot helps learners identify the knowledge and skills related to the lesson on Chemical Properties of Metals at the appropriate level.

○ Absolutely not ○ Yes but not fully ○ Full

2. The learning process with the chatbot helps learners identify ways to test and evaluate the learning outcomes of the lesson on Chemical Properties of Metals at the appropriate level.

○ Absolutely not ○ Yes but not fully ○ Full

The learning process with the chatbot helps learners identify the problems of the lesson Chemical Properties of Metals at the level of:

○ Absolutely not ○ Yes but not fully ○ Full

4. The learning process with Chatbot helps learners identify the learning tasks of the lesson Chemical Properties of Metals at the level of:

○ Absolutely not ○ Yes but incomplete ○ Complete

5. The learning process with Chatbot helps learners create a schedule to self-study the lesson Chemical properties of metals at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

Part 2: Assessing the ability to develop proactive capacity in the learning process of learners (from 6 to 10)

6. The learning process with Chatbot allows learners to look up terms, concepts, knowledge units... and the connections between knowledge units in the lesson necessary for them at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

7. The learning process with Chatbot allows learners to experiment and correct errors when self-studying at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

8. The learning process with Chatbot helps learners explain the nature of chemical phenomena in experimental videos used in the Chemical Properties of Metals lesson at the appropriate level.

○ Absolutely not ○ Yes but not complete ○ Complete

9. The learning process with Chatbot helps learners identify chemical knowledge for practical problems related to the content of the Chemical Properties of Metals lesson at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

10. The learning process with Chatbot helps learners identify chemical knowledge to solve learning situations/tasks in the Chemical Properties of Metals lesson at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

Part 3: Assessing the ability to develop the capacity to improve the learning efficiency of learners (from 11 to 15)

11. The learning process with Chatbot introduces learners to the types of exercises in the Chemical Properties of Metals lesson at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

12. The learning process with Chatbot introduces learners to sample solutions for exercises in the lesson Chemical Properties of Metals at the level of:

○ Absolutely not ○ Yes but not complete ○ Complete

13. The learning process with the chatbot provides learners with multiple-choice questions to practice their knowledge of the lesson on Chemical Properties of Metals at the specified level.

○ Absolutely not ○ Yes but not complete ○ Complete

14. The learning process with Chatbot provides learners with a learning history, enabling them to search for and correct errors, identify limitations, and adjust their learning methods to meet the requirements of the lesson on Chemical Properties of Metals at the specified level.

○ Absolutely not ○ Yes but not complete ○ Complete

15. The learning process with Chatbot provides learners with measures to correct errors, address limitations, and adjust their learning methods to meet the requirements of the lesson on Chemical Properties of Metals at the specified level.

○ Not at all ○ Yes but not fully ○ Fully

Part 4: We would like to ask you to share information about your professional qualifications and academic experience.

16. Your full name (including academic title/degree):

17. Your work unit:

18. Your years of work:

19. Your phone number:

20. Your email: