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AI Chatbot: A Teaching Tool to Support the Development of Self-learning capacity in Chemistry for High School Students

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ABSTRACT: In the context of digital transformation and the rapid development of artificial intelligence (AI), the use of AI technology in general and AI Chatbot in particular in education has become a significant trend. There is an increasing number of studies and practical applications of AI Chatbot in teaching and learning. Research indicates that AI Chatbot bring numerous benefits to the teaching process of subjects such as foreign languages, mathematics, science, chemistry, and more. This paper analyzes the potential of AI Chatbot in supporting the self-learning process of high school students in Chemistry. By integrating artificial intelligence technology, AI Chatbot not only provide instant information but also personalize the learning process, helping students enhance their self-learning capacity more effectively. Specifically, the study focuses on identifying the relationship between AI Chatbot and the self-learning process in Chemistry, while also proposing methods to implement AI Chatbot in Chemistry education to improve self-learning capacity for high school students in particular and for other subjects and levels of education in general.

KEYWORDS: Artificial intelligence, AI Chatbot, chemistry teaching, self-learning capacity, student, teaching tools.

1. INTRODUCTION

In the current trend of educational innovation, enhancing students' self-study competence is one of the critical tasks, enabling them to actively acquire and apply knowledge. Chemistry, as a subject that combines both theoretical and practical aspects, requires students not only to understand the lesson content but also to practice and verify knowledge. However, there are several challenges in self-studying chemistry, such as the vast amount of knowledge, the demand for logical thinking, analytical skills, problem-solving abilities—competencies that students need to develop through self-study. Additionally, the high requirement for experimental practice and the close interconnection of knowledge content pose significant challenges for students. Hence, there is a demand for a learning tool that can support students in studying chemistry more easily, allowing them to absorb theoretical knowledge effortlessly while also facilitating practical application and real-world problem-solving.

Self-study competence is an essential and crucial skill that learners need to possess during their educational journey. In the learning process, students cannot be provided with all the knowledge they require; therefore, they need to be equipped with the necessary skills to self-study. This not only helps them acquire knowledge independently but also fosters lifelong learning abilities, enabling them to adapt and thrive in a knowledge-based society and in the context of international integration. Consequently, fostering and developing self-study competence among students is a fundamental task of the teaching process.

With the advancement of artificial intelligence technology, AI Chatbot are rapidly being applied and influencing various aspects of society, including education. AI Chatbot can perform multiple tasks quickly, efficiently, and accurately. They have the ability to provide information, answer questions instantly, and assist students in monitoring and adjusting their personal learning progress, helping them overcome challenges in knowledge acquisition. With these advantages, AI Chatbot can become a powerful tool in supporting students to self-study chemistry effectively.

2. RESEARCH RESULTS

2.1 The Concept of Self-Study and AI Chatbot

According to Nguyen Minh Giam (2024), self-study is a personal learning strategy where learners recognize the importance of learning and take specific actions to acquire a system of knowledge, skills, techniques, and human experiences, thereby improving themselves. This can be guided by teachers or based on learners' personal needs. Bolhuis (1996) and Garrison (1997) define self-

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study as the integration of self-management and self-monitoring by learners. It is a process where learners track, evaluate, and adjust their cognitive strategies, acting as active participants in collaboration with teachers and peers.

Self-study can be demonstrated through activities like reading and researching textbooks, newspapers, listening to radio broadcasts, watching educational programs, attending lectures, and engaging in discussions with experts and peers. Effective self-study requires learners to select appropriate materials, identify key points, summarize, outline, and utilize resources such as dictionaries and libraries. It demands independence, self-discipline, and persistence, along with a positive, inquisitive attitude and enthusiasm for learning.

According to Abbasi, S., & Kazi, H. (2014), chatbot systems are effective tools for measuring and enhancing learning outcomes. Students using chatbots in their studies tend to have better retention and academic performance. The quality of students' questions also improves through interactions with chatbot systems. AI Chatbot are intelligent conversational systems capable of processing human language. They are programmed to interact with users naturally, track context, and utilize integrated knowledge bases (Wailthare et al., 2018). They understand user inputs and respond meaningfully based on preloaded information (Kumar & Ali, 2020). Straková and Válek (2024) affirm that AI Chatbot optimize teaching and learning by summarizing texts, quickly retrieving information, personalizing content, and assisting teachers in lesson preparation.

Thus, AI Chatbot are intelligent conversational systems integrating artificial intelligence technology, designed to interact naturally with humans. They can understand and respond in natural language, remember context, integrate knowledge, and comprehend user intent to provide accurate feedback. In education, AI Chatbot effectively support learners by providing instant responses, personalizing content according to individual levels, cognitive speeds, and learning styles. Acting as learning assistants, they can suggest exercises, serve as intelligent online learning platforms, and provide timely responses, offering 24/7 support. They not only help students develop self-study skills but also encourage creativity.

Self-study requires learners to be self-disciplined, proactive, persistent, and capable of self-management in acquiring human knowledge. Meanwhile, AI Chatbot serve as flexible tools, providing a modern learning environment that allows learners to access information quickly, accurately, and effectively. With their instant feedback capabilities, AI Chatbot help learners address questions or problems encountered during self-study. Identifying the synergy between self-study and AI Chatbot in teaching will enable educators to develop more intelligent AI Chatbot-based virtual teachers to support the teaching and learning process effectively.

2.2 Characteristics of High School Students' Chemistry Learning

In the general education curriculum, Chemistry is a subject within the group of natural sciences and serves as a central discipline. Chemistry is a branch of natural science that studies substances and their transformations. It integrates theory and experimentation closely, acting as a bridge between other natural sciences such as physics, biology, medicine, and geology. Chemistry is both a theoretical and experimental science with a relatively large volume of knowledge. Learners are required to understand and simultaneously apply theoretical and experimental knowledge, including chemical formulas, physical and chemical properties, the natural states of substances, methods of preparation and applications, physical quantities related to substances, parameters, constants, and experimental data. Chemistry fosters and develops students' chemistry competency – a distinctive manifestation of natural science competency, consisting of the following components: understanding chemical knowledge; exploring and discovering the natural world from a chemical perspective; and applying acquired knowledge in practical contexts.

The content of chemistry knowledge is characterized by its sequential and continuous nature across different educational levels. If students fail to grasp the knowledge of one lesson, they will struggle to understand and learn the subsequent content. Moreover, chemistry knowledge is intricately built upon and interconnected with one another. It requires students not only to comprehend theoretical concepts but also to verify this knowledge through experimental practice.

Given the unique nature of Chemistry, effective learning necessitates students' self-study abilities. Self-study in Chemistry has distinct requirements compared to general self-study activities. To self-study Chemistry, students must possess a systematic understanding of the subject and comprehend the interrelationships among concepts and agents. For instance, a chemical reaction only occurs in the presence of sufficient catalysts; thus, writing a chemical equation would be meaningless if students forget the catalysts. Furthermore, students must know how to perform and successfully carry out chemical reactions to verify their understanding. Conducting chemistry experiments independently poses significant challenges for students; besides knowing the

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formulas and procedures, they must also exhibit carefulness and dexterity during experiments to ensure safety for themselves and the equipment.

In summary, to learn Chemistry effectively, students need to develop self-study skills and enhance their chemistry self-study competency, as outlined by Nguyen Minh Giam and colleagues (2023). This involves the ability to identify learning tasks, set learning objectives, plan learning activities, adopt suitable learning styles, utilize learning resources, and actively recognize and address mistakes or limitations during the learning process. These efforts aim to engage with fundamental aspects of chemistry, enabling students to understand, apply, and develop chemistry competencies, which include: understanding chemical knowledge, exploring and discovering the natural world from a chemical perspective, and applying chemical knowledge in practical contexts (Ministry of Education and Training of Vietnam, 2018).

By studying the characteristics of chemistry learning and the components of chemistry competency, teachers can identify core factors that help students self-manage their learning process: self-orientation, independent knowledge-seeking, and self-assessment and adjustment of learning progress. Based on these insights, teachers can design and plan lessons that integrate AI technology into teaching, paving the way for modern teaching methods. This approach supports teachers in reducing time and effort while enhancing the teaching of Chemistry in high schools.

2.3 Self-learning capacity in Chemistry Supported by AI Chatbot

Self-learning plays a significant role in shaping personality, fostering learners' habits of independent thinking and acting to solve challenges in both learning and life. Furthermore, self-learning encourages a passion for learning, curiosity, and the desire to reach greater heights, living with ambitions and dreams (Phan Bich Ngoc, 2009). According to Pham Van Tuan (2013), self-learning has fundamental characteristics as a process of self-directed, active, and independent learning under the guidance of teachers. During the self-learning process, learners mobilize psychological functions such as cognition, attitude, and behavior. Self-learning occurs in a learning environment and is influenced by various learning conditions. As Nguyen Minh Giam et al. (2023) suggested, to develop chemistry competence, students need self-learning capacity, which includes the ability to identify learning tasks, set learning goals, create learning plans, adopt appropriate learning styles, utilize learning resources, and recognize and overcome errors and limitations during the learning process. This proactive approach enables students to engage with fundamental elements of chemistry and develop their chemistry-related competencies.

Self-learning capacity refers to the learner's ability to engage in self-directed learning activities. It begins with the learner's intrinsic motivation to learn. When driven by this motivation, learners choose to study independently, voluntarily, and conscientiously. During the self-learning process, learners face various challenges, such as the complexity of knowledge, lack of information, limitations in learning methods, as well as personal health and emotional states. Addressing these challenges requires learners to adopt suitable learning strategies, accompanied by determination and perseverance, to overcome them.

In the Chemistry curriculum, each component of general and subject-specific competencies is integrated into the content strands and topics, presented as learning objectives at varying levels of difficulty. Therefore, during the learning process, students need to be proactive, independent, and self-motivated in exploring, understanding, and mastering chemistry knowledge effectively to solve problems in chemistry learning and achieve good academic results. Chemistry self-learning capacity is developed through the study of Chemistry as a subject. It can be understood as the ability to study chemistry materials to engage with fundamental elements of the discipline. Students identify learning objectives, create personal learning plans to achieve these objectives, and know how to search for and utilize chemistry resources to address chemistry-related problems. Simultaneously, students self-assess and adjust their learning activities to align with the requirements of the Chemistry subject and the broader educational goals.

In the context of digital transformation and the application of artificial intelligence (AI) in teaching and learning, integrating small knowledge units of Chemistry with the foundational structure of AI Chatbot technology into Chemistry education brings significant benefits. AI Chatbot not only meets the content requirements of Chemistry education—from explaining basic concepts of chemistry, atoms, molecules, chemical reactions, to providing detailed guidance on balancing equations and experimental procedures—but also supports the development of students' self-learning capacity. Specifically, AI Chatbot provides timely and rapid feedback, helping students orient their learning process through searching and referencing materials, self-assessing knowledge through sample exercises, and self-evaluating and adjusting their learning progress. This enhances students' proactivity, confidence, and problem-solving abilities in learning while creating an interactive and personalized learning environment.

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Thus, the integration of Chemistry content with AI Chatbot aims not only to effectively deliver knowledge but also to develop students' self-learning, self-orientation, and self-regulation competencies. This is an urgent requirement in modern education, where technology serves as a powerful tool to create a contemporary learning environment, encouraging students to continuously strive and achieve higher academic results.

2.4 The Use of AI Chatbot in Teaching Chemistry

Based on the study of the compatibility of Chemistry self-learning capacity with AI Chatbot support, the author proposes the following relationship between Chemistry teaching, self-learning capacity, and AI Chatbot:

- Teaching Chemistry is the process of forming and developing students' Chemistry qualities and competencies, including components such as chemical cognition, exploring the natural world through a chemical lens, and applying learned knowledge and skills.
- Self-learning capacity is students' ability to actively, independently, creatively, and flexibly acquire Chemistry knowledge to achieve learning objectives. This includes the ability to define learning tasks, objectives, plans, and styles suited to themselves; the ability to search for and process Chemistry information effectively; the ability to solve Chemistry-related problems in real-life contexts; and the ability to self-assess and adjust their learning methods.
- AI Chatbot can support Chemistry teaching and contribute to the development of Chemistry self-learning capacity in students through the following roles: providing intelligent and immediate Chemistry knowledge tailored to individual learners, creating an interactive and engaging learning environment, promoting student participation and initiative, and supporting self-learning and competence development.

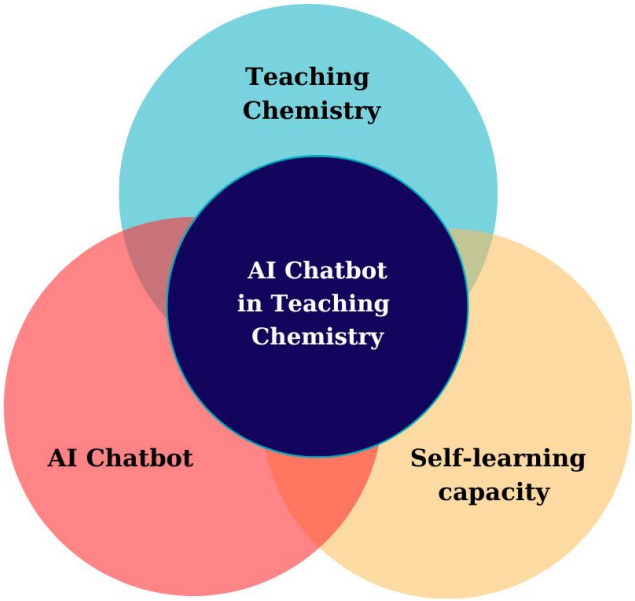

Figure 1. Model of Using AI Chatbot to Develop Chemistry Self-learning capacity for High School Students

Through the relationship between Chemistry teaching, self-learning capacity, and AI Chatbot, teachers are guided to use AI Chatbot in teaching through learning scenarios developed by educators. AI Chatbot enhance self-learning capacity by combining machine learning and artificial intelligence methods to customize learning content to suit the needs and abilities of each student, providing automated support and instant feedback, thereby creating a personalized and effective learning environment for each student. This helps students develop self-learning capacity in Chemistry for high school students.

To build an AI Chatbot—a virtual teacher—for teaching any subject, program, or lesson, teachers must study its compatibility and meet the requirements of three elements: the teaching curriculum, defined competency development, and the AI Chatbot platform.

AI Chatbot can help students develop self-learning capacity in Chemistry by enabling them to define their learning objectives, understand what they need to achieve after a lesson or topic, outline learning tasks, and plan their studies effectively and scientifically. Specifically, AI Chatbot assist students in the following ways:

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Explaining scientific concepts: AI Chatbot help students understand scientific concepts, from simple to complex. When students encounter difficulties in understanding a specific concept, they can ask the Chatbot, which will provide a simplified explanation.

Guiding problem-solving: During exercises or Chemistry problem-solving, AI Chatbot guide students step-by-step, provide related Chemistry formulas (e.g., mole number, mass, molar mass, solution concentration), and assist in balancing equations and solving calculations. This helps students learn to balance chemical equations, memorize formulas, and solve Chemistry problems independently using various methods.

Reinforcing and reviewing knowledge: AI Chatbot provide questions or exercises to reinforce learned knowledge. Students can request specific exercises, and Chatbots will instantly generate them. By offering questions and exercises, students can consolidate their knowledge, evaluate their understanding, and take timely measures to improve their learning outcomes.

Providing reference materials: AI Chatbot suggest resources for deeper exploration of scientific topics or expanding existing knowledge. By accessing diverse information sources, students gain a comprehensive view of their study topics. Chatbots also update new knowledge, helping students maintain a broad perspective on current scientific topics and extend their understanding.

Chemistry experiments are an essential component of Chemistry learning. AI Chatbot assist students in understanding experimental processes or principles, explaining detailed steps, expected products, and observed phenomena. Chatbots can also provide simulations for scientific experiments, explaining the phenomena involved. This helps students better understand scientific principles and their practical applications.

By performing these tasks, AI Chatbot create a personalized, flexible, and effective learning environment for students. Specifically, Chatbots simplify theoretical knowledge, guide detailed steps for problem-solving, balance chemical equations, and simulate experiments, enabling students to grasp and apply knowledge intuitively. Through continuous support, the system encourages students to self-check, evaluate their learning progress, and adjust according to their pace, fostering proactivity, self-learning, and creativity. Teachers can also use this approach to develop AI Chatbot for other subjects and higher education programs.

3. CONCLUSION

In summary, the AI Chatbot is suitable for fostering self-learning competencies among high school students. Through the tasks that the AI Chatbot can support, it is evident that the use of AI Chatbot in teaching Chemistry not only enhances students' self-learning abilities but also contributes to the innovation of teaching methodologies. The AI Chatbot acts as a virtual assistant, helping students actively access knowledge while reducing the workload for teachers. Thanks to the AI Chatbot, students can easily access and utilize knowledge to solve complex problems in Chemistry. This not only improves the quality of learning in this subject but also facilitates the transfer of self-learning skills to other subjects. Every response and support provided by the system helps alleviate the pressure on students during their self-learning process, while also offering teachers a more accurate tool for monitoring and evaluating each student's learning progress.

Thus, the application of AI Chatbot in the teaching and learning process of Chemistry is not merely about knowledge assistance but also a comprehensive strategy for developing self-learning competencies. It contributes to building a solid foundation for lifelong learning in the context of digital transformation and international integration. This is a key factor in establishing a modern education system that meets the demands of the 4.0 era, where self-learning and the ability to manage knowledge independently play essential roles in personal and community development. In the future, AI Chatbot promise to become an important tool, serving as a valuable resource in education, particularly in enhancing students' self-learning capacities in Chemistry and other subjects at various educational levels, especially in higher education programs.

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