APPLICATION OF CHATBOT IN TEACHING THE LAW OF CONSERVATION OF MOMENTUM IN PHYSICS 10 TO FOSTER SELF-STUDY COMPETENCE FOR STUDENTS

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Abstract. This article presents the results of research on the application of Chatbot for building content and providing support to students in learning about the Law of Conservation of Momentum in Physics, enhancing their self-study skills. Drawing from previous studies on self-directed learning and Chatbot implementation in education, a dedicated Chatbot for teaching physics was designed. The research outlines the process of implementing this Chatbot to foster students' self-directed learning abilities. Furthermore, the article proposes the construction of a database and lesson plan using Chatbot and describes the experimental application of Chatbot with 10th-grade students from the High School for Gifted Students at VNU University of Sciences. Through surveys and analysis of learner feedback, appropriate assessments and recommendations are made regarding the application of Chatbot to develop students' self-study abilities in physics teaching.

Keywords: Chatbot; self-study competence, momentum, teaching physics.

1. Introduction

Self-control and self-study capacity are common competencies included in the overall general education program so that subjects and educational activities are oriented toward the development of students [1]. Self-learning enables students to acquire the ability to explore, analyze, and study themselves for life to constantly update new knowledge and integrate with the development of society. Therefore, fostering students' self-study ability is necessary for teaching in general and physics in particular [2]. The current trend is the application of artificial intelligence (AI) technology in general and Chatbots, in particular, to support students in self-study to help students foster mathematical competence in teaching physics [3], such as developing a system that automatically answers users' questions on behalf of teachers in teaching or applies artificial intelligence to build software to help students solve problems [4], initial studies show that the Artificial intelligence contributes to improving the efficiency of teaching and learning physics.

In this article, we continue to study the advantages of Chabot in education to propose a teaching process using Chatbot to foster self-study ability for students. We have designed a separate Chatbot for teaching Physics and built a lesson plan on the law of conservation of momentum to test the effectiveness of the Chatbot in teaching Physics to develop mathematical competence for 10th graders at High School for the Gifted of VNU University of Sciences.

2. Content

2.1. Self-study ability

According to Do Huong Tra, self-study is a complex activity, including skills and techniques, associated with corresponding motivations and habits for learners to meet job requirements [2]. Self-study includes learners' internal forces that determine their development. According to Nguyen Canh Toan, self-study is brainstorming, thinking, applying intellectual capacity (observing, comparing, analyzing, synthesizing, etc.), and sometimes even muscles (when using tools). with their qualities, motives, feelings, human outlook, and worldview (honesty, objectivity, willingness, not afraid of difficulties, not afraid of suffering, perseverance, patience, passion for science, the will to pass the exam, turn difficulties into advantages) to occupy a certain field of human knowledge, making that field their own [5]. Thus, self-study is an important form of human learning. It shows a different and more active way of learning than in class, group study, etc. Self-study shows initiative, positivity, and independent inquiry. Thereby students acquire knowledge and form skills for themselves as well as adapt their strengths and knowledge to their needs.

Self-study capacity is the ability to self-learn knowledge and apply that to solve a certain problem. To foster students' self-study ability, teachers need to analyze two main factors affecting the self-study process. The first is due to external factors affecting the teaching methods of the teacher, and the main internal factors come from the spirit, will, confidence, and passion of the students [5]. Therefore, the teaching process must always encourage and motivate students, and create confidence, motivation, and goals for students to be active in self-study. In the 2018 General Education Program, at the upper secondary level, the self-study and self-improvement component with specific requirements to be met [1] such as: (1) identifies learning tasks based on achieved results; knowing how to set detailed and specific learning goals and overcome limitations; (2) evaluate and adjust the study plan; form their learning style; search, evaluate and select materials suitable for different learning purposes and tasks; record information in an appropriate form, convenient for memorization, use and supplementation when necessary; (3) self-recognize and correct their errors and limitations in the learning process; reflect on how to learn, draw lessons to be able to apply in other situations; know how to self-regulate learning; (4) know how to cultivate according to personal striving goals and civic values regularly.

Physics is a subject associated with practical and experimental elements, so using only textbooks does not meet all the learning needs. It is necessary to have more teaching aids to support the self-study process. Therefore, self-study capacity in teaching physics is the ability to self-search and perceive physical knowledge (concepts, laws, physical theories, methods of physical perception, and applications of physics) and apply them to solve new or similar problems of Physics at a higher quality [5].

2.2. Using Chatbot to support students to foster self-study ability

2.2.1. Using Chatbot in Teaching

Chatbot is a program designed to simulate a conversation between a computer and a user over the Internet. Chatbots use artificial intelligence (AI) and natural language processing to understand users' questions and automatically answer them. Chatbots often communicate with users in the form of messages or sounds [6]. Chatbot is a combination of pre-programmed scripts and has the capability of self-learning during interactions. In the field of education, Chatbot can help teachers with activities [7] such as: (1) interacting and answering questions in the subject for students; (2) assigning learning tasks to students; (3) checking and evaluating students' answers; (4) collecting questions and issues that students do not understand and still have questions about;

(5) advising students on study programs; (6) providing suggestions, resources for students (7) sending notifications to each student about learning outcomes; (8) supporting student self-study.

Compared to other teaching support platforms such as Google Classroom, Google Sites, and Microsoft Team, etc., Chatbot has more advantages in helping students answer short questions automatically and quickly. Chatbot is also integrated into *Zalo* or *Messenger,* which are popular and familiar applications used by students and teachers every day.

Currently, there are many tools to create Chatbot, but in Vietnam, there are some tools that are completely free and widely applied, such as *Chatfuel, Messnow, ManyChat, ChattyPeople, Harafunnel*, etc. Among them, to apply for self-study, we chose *Messnow* to set up a Chatbot teaching physics and named it Chatbot VL-AI. This chatbot has several features such as: (1) the interface is entirely in Vietnamese; (2) there is a menu with detailed step-by-step instructions for installing and deploying the Chatbot; (3) integration with *Zalo* and *Messenger* messaging apps; (4) multilingual capabilities with more than 50 languages worldwide; (5) diverse application store, helping users integrate more functions.

Chatbot VL-AI helps students easily interact, exchange lessons, and create a feeling of closeness with students.
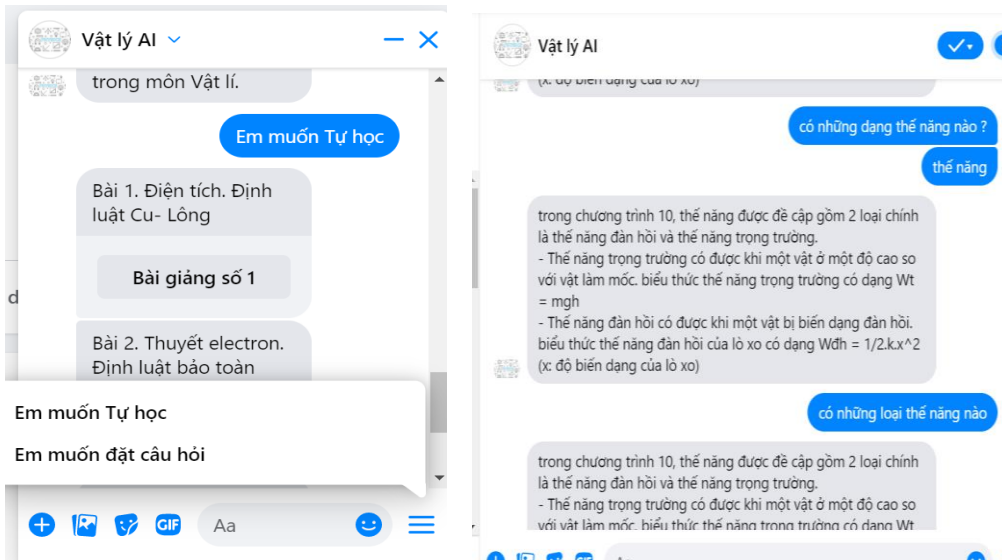

Figure 1. Students interacting with Chatbot VL-AI

The teacher uses Chatbot VL-AI to help the student answer questions that need to be answered as described in the following diagram:
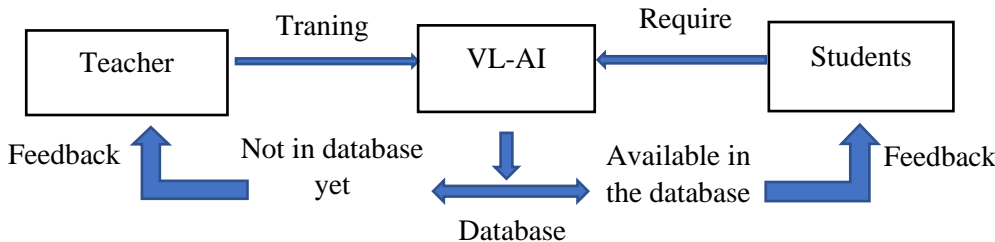

Figure 2. Working process of Chatbot VL-AI

The teacher is the person whose role is to help the VL-AI Chatbot work effectively. To train the VL-AI Chatbot, the teacher can divide lessons into basic knowledge and practice exercises to build suggested menus, short questions, inferences, and comparisons between knowledge or its application in life. That is the process of training Chatbot VL-AI on each specific question by setting up an answer scenario on Messnow.

The student who places a request with the VL-AI Chatbot will receive a response if the question matches or nearly matches the database. However, student's questions and answers are diverse, and there are situations that the teacher does not anticipate. These questions will be collected and processed by the teacher and added to Chatbot's database. Therefore, to help Chatbot VL-AI answer as many questions as learners, it needs to be equipped with a massive amount of data, covering all the knowledge of the lesson. Consequently, it is impossible to perfect the system in a short time, but it needs to be constantly updated like a student accumulates and cultivates new knowledge. The VL-AI Chatbot training process is described by the following cycle:
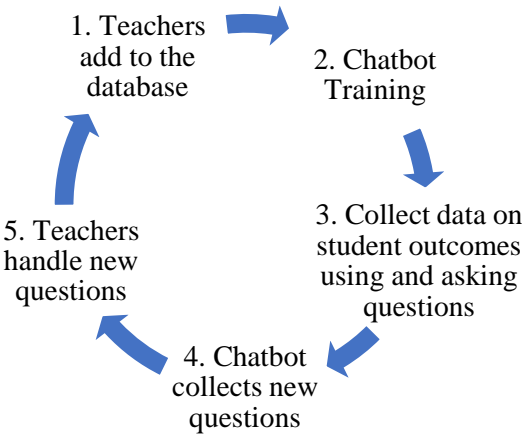

Figure 3. Collect data on outcomes from students' experiences

After step 5, the process will be repeated cyclically. New questions after being processed will be continuously added to the database.

2.2.2. VL-AI Chatbot supports student self-study

In the era of Industrial Revolution 4.0, people can connect, search for information, work, study, etc. on social networking platforms. Compared with the traditional form of self-study or self-study on the Internet, self-study with Chatbot VL-AI has several advantages in implementing a self-study plan as described in Table 1.

In Physics, self-study ability is developed by assigning students to solve problems with increasing levels of self-study. According to Do Huong Tra [8], at a high level of self-study, students self-study with materials that have been modularized according to the teacher's pedagogical ideas, and the Internet environment is ideal for organizing self-study activities. With its advantages, Chatbot VL-AI is a specific application that can reach closer to students and can help students learn by themselves easily and effectively.

Table 1. Advantages of VL-AI Chatbot in supporting students

Evaluation Criteria	Traditional self-study	Self-study with the support of the Internet	Self-study using Chatbot VL-AI
Resource selection	Students' self-study according to learning materials such as textbooks, notebooks, and reference books.	Students can find a wider variety of resources, but because they are extensive, choosing the right material for the curriculum can be difficult.	Students easily review the 's system, and resources consistent with the lesson content.
Searching for knowledge content	Students' self-study the knowledge in the textbook and work hard to find other extended information.	Students can look up unknown information, but many results will not be verified for accuracy, or too many making it difficult to choose.	Students can search for a lot of knowledge related to the lesson content quickly, accurately, and specifically answered by Chatbot VL-AI.
Seeking support from others when in trouble	Difficulty communicating and answering questions at home	Have contact to exchange information with friends even while studying at home, but it is difficult to interact with teachers.	Can share difficulties, and questions, and seek help from teachers through Chatbot VL-AI.

2.2.3. Proposing a framework for self-study capacity in physics with the support of a Chatbot VL-AI

Specific expression of learners' self-learning ability when using VL-AI Chatbot is divided into competency components with specific behavioral indicators [2].

Table 2. Competence framework for self-study Physics with Chatbot VL-AI usage

No.	Manifestations of ability	Behavioral index
1	Identify motivation and learning goals.	1.1. Determine what to learn.
		1.2. Identify knowledge and skills related to what you already know.
2	Make a self-study plan.	2.1. Learn about Chatbot VL-AI.
		2.2. Choosing a learning method.
		2.3. Build a self-study process.
3	Implement a self-study plan	3.1. Working with documents.
		3.2. Working with Chatbot VL-AI.
4	Self-assess, test, and adjust the self-learning process.	4.1. Rate your results.
		4.2. Assessment can adjust the study plan.

For the VL-AI Chatbot to support students in the process of self-study, the research proposes the process of organizing teaching and retraining for students' self-study capacity using the VL-AI Chatbot as follows:
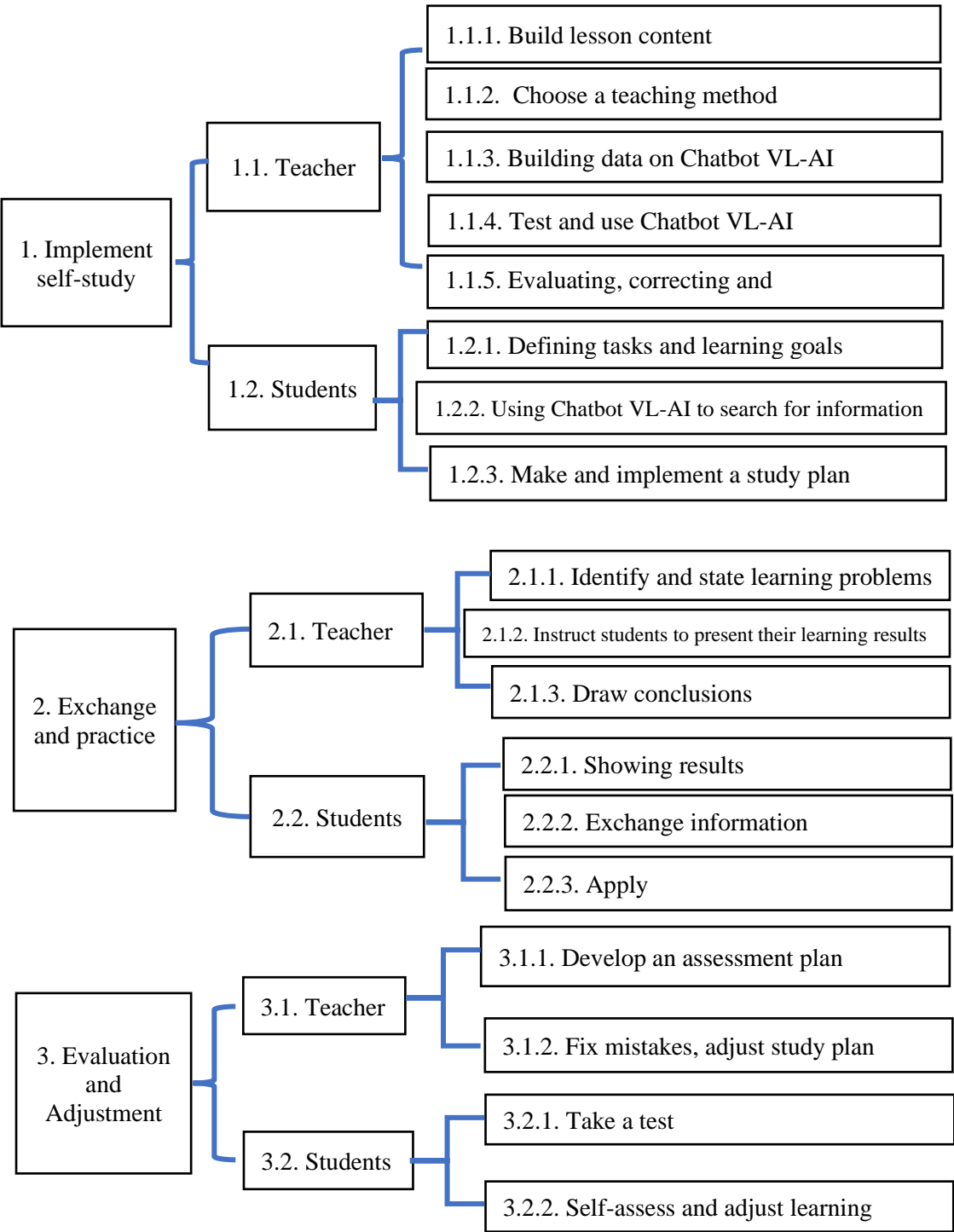

Figure 4. The process of using Chatbot VL-AI to promote self-learning in physics teaching

Preparing students before class is the most important and contains many components and behavioral indicators of self-study ability that students can foster [9]. When students study at home, their self-study and independence are also shown more clearly than in-class learning. Therefore, to promote the self-study ability of students, Chatbot VL-AI directly supports students in the preparation process before class. Therefore, helping students learn new knowledge more easily with the role of orientation.

2.2.4. Using Chatbot VI-AI to foster students' self-study ability in teaching the law of conservation of momentum

Based on the specific behavioral performance indicators of the ability to self-study Physics using the Chatbot VL-AI support tool and the process of building the above teaching process, research, and application to build Chatbot VL-AI guide self-study the law of momentum conservation.

In the framework of the article, the study presents the results of the impact of Chatbot VL-AI on students' self-study period before class as shown in Figure 4.

The goal of developing a teaching plan to help students determine the learning task is to learn about Chatbot VL-AI and self-study with Chatbot VL-AI, self-determine concepts, expressions, and units of calculation, the physical meaning of momentum, the law of conservation of momentum, answer questions in exercise sheets, build a self-study plan with Chatbot VL-AI.

For teachers, when implementing teaching with the support of Chatbot VL-AI, it is necessary to follow these steps:

- Step 1: Build lesson content: Learn the concept of momentum and the law of conservation of momentum.

- Step 2: Select teaching method: Reverse classroom model, students' self-study using Chatbot VL-AI, then provide content that students will discuss in class.

- Step 3: Build data on Chatbot VL-AI: Set up oriented menus according to the course of the lesson, learning cards, concepts, and applications related to knowledge of momentum, and the law of conservation of dynamics quantity.

- Step 4: Test run and use Chatbot VL-AI.

- Step 5: Collect student feedback data via Chatbot VL-AI.

- Step 6: Evaluate, repair, and supplement data on Chatbot VL-AI.

After completing the data system on the VL-AI Chatbot, the teacher conducts remedial and supplementary checks to train the VL-AI Chatbot when students self-study.
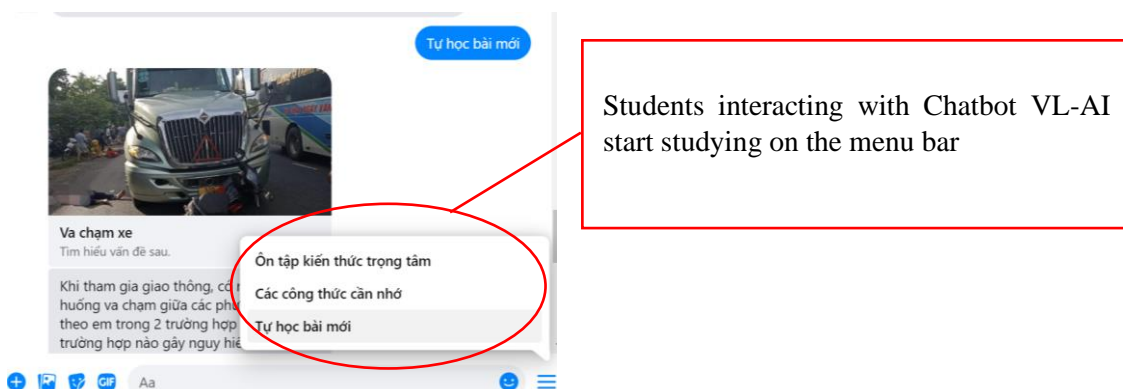

Figure 5. Students start the lesson on Chatbot VL-AI

In the process of teaching in class, teachers need to organize activities to help students understand the learning problem so that students determine the purpose of the lesson is to learn new concepts related to the collision between objects, and the rules governing the collision process between objects [10]. Teachers using Chatbot VL-AI raise the problem: When participating in traffic, there are many collision situations between vehicles; according to you, in the two cases below, which is more dangerous and why? Star? Situation: Cars traveling at 80km/h and container trucks traveling at 60km/h collide with another vehicle stopping at a red light.

Students study by themselves at home before going to class to raise problems and predictions, then click on the lesson, Chatbot VL-AI introduces the lesson as follows:
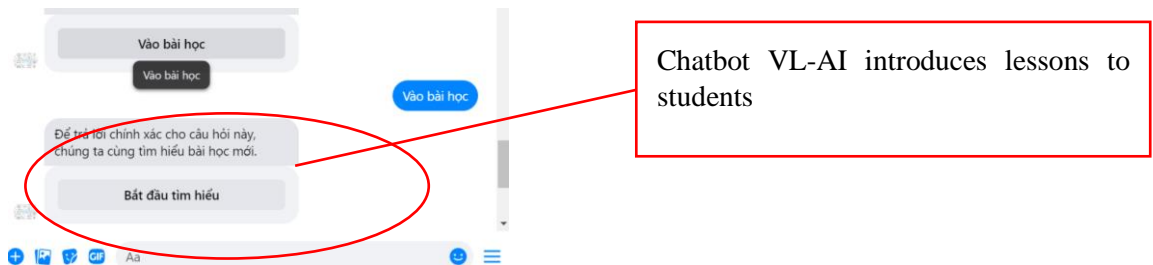

Figure 6. VL-AI Chatbot introduces the lesson

After students complete the above activities, it comes to the problem of learning about the concept of momentum to help students self-determine the knowledge and skills they need to learn about momentum: state concepts, expressions, and represent momentum vectors, get the specific examples of momentum. The teacher assigns tasks on study card 1 with 2 questions for students to learn with Chatbot VL-AI to give themselves to lead to the concept of momentum as follows:
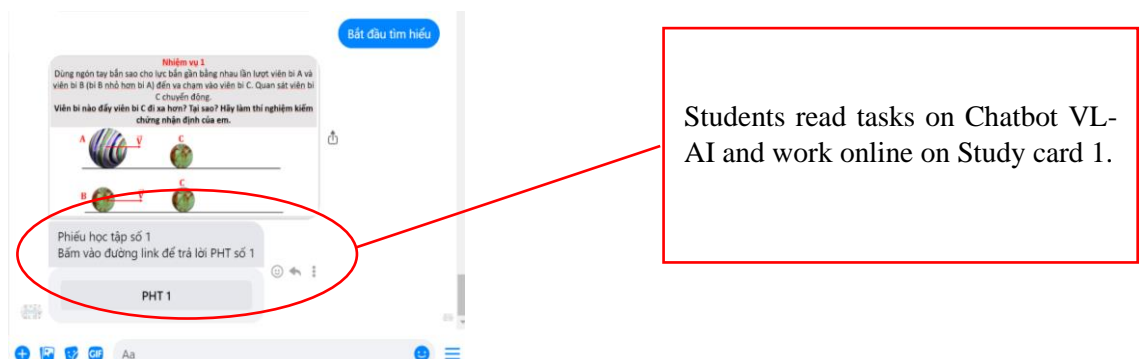

Figure 7. Students perform task 1 on Chatbot VL-AI

Study card 1

Question 1: In lesson 1, compare the velocities of objects A and B when they collide with object C. Compare the distance traveled by C in the two cases and tell what affects the difference between those results?

Question 2: In lesson 2, does this speed affect the distance C can travel? From there, the motion of object C received from object A or B depends on what factors?

After completing study card 1, students click on the button conclusions so that the VL-AI Chatbot gives the concept of the lesson: Velocity or mass cannot be used alone to represent the capacity of a moving object to apply force. As a result, people introduced a new concept that is momentum.

Finally, there is an application activity that helps students determine the unit of momentum, calculate the momentum of a moving object, and answer questions at the beginning of the lesson. The teacher assigns tasks on the worksheet for students to self-study with Chatbot VL-AI as follows:
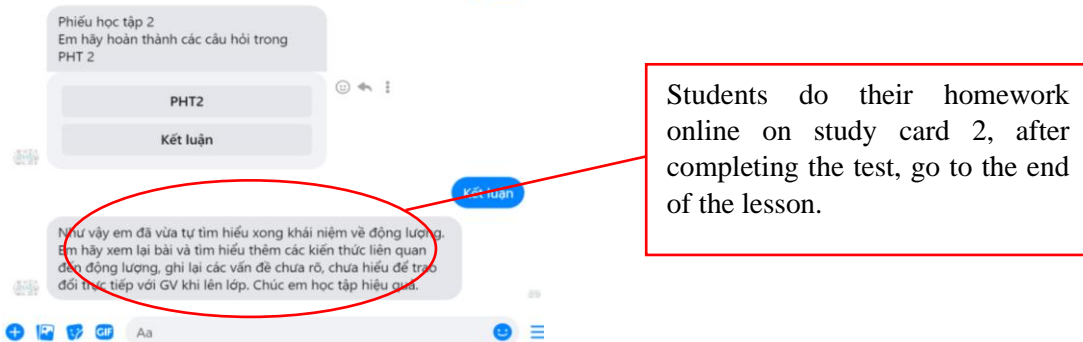

Figure 8. Students working on VL-AI Chatbot with study card 2

Study card 2

Question 1: From the momentum formula, can you determine the unit of momentum?

Question 2: Please answer the original question, will passenger cars or container trucks cause more serious accidents and why?

Question 3: Compare the momentum of the objects in the following cases:

A car of mass 3 tons is moving with a speed of 48 km/h.

A bullet of mass 500g is moving with a speed of 200m/s.

An electron of mass $9,1.10^{-31}$ kg is moving with a speed of 2.10^7 m/s.

After the self-study process at home with Chatbot VL-AI, students grasped the knowledge related to the concept of momentum, applied it to explain some situations, and solved simple exercises. When going to class, teachers will discuss with students self-study problems, and questions in workbooks and continue to learn about the concept of momentum, advanced applications, and assessment.

2.3. Pedagogical experiment

To evaluate students' self-study ability at home with the support of Chatbot VL-AI, we conducted an experiment at the High School for the Gifted of VNU University of Sciences. The experimental period was from March 13, 2023, to March 24, 2023, the subjects were 40 students of class 10A2CLC. We have designed the lesson plan according to the reverse class model of Momentum - Physics Program 10. Student's assessment results will be collected through the results in the Student's Study Sheet and Student Rubric. Also evaluating the support of Chatbot VL-AI in supporting students' self-study will be through questionnaires. Analyze the results in the study card and post-lesson assessment test and on the student's, rubric based on the behavioral indicators of self-study ability below (Table 3).

Table 3. Behavioral index assessment of self-study ability using Chatbot VL-AI

Behavior index	Level 1 (good)	Level 2 (fair)	Level 3 (average)
1.1. Determine what to learn	Determining the lesson is the concept of momentum.	Determining the research content explains the collision in the opening situation.	The content of the lesson has not been understood.
2.1. Learn about Chatbot VL-AI	Quickly learn and familiarize yourself with the VL-AI Chatbot. Use Chatbot VL-AI proficiently, efficiently, and effectively.	Quickly learn and familiarize yourself with the VL-AI Chatbot. Know how to use Chatbot VL-AI but not yet proficient.	It takes a lot of time to learn but still do not understand and need the guidance of the teacher.
3.2. Working with Chatbot VL-AI	Self-study with Chatbot VL-AI and fully and accurately answer study sheets.	Self-study with Chatbot VL-AI correctly completes 1 study sheet.	Self-study with Chatbot VL-AI but answer the study sheets incompletely and incorrectly.
4.1. Rate your results	Self-assess the self-study process and determine the factors that need to be changed.	Self-assess the self-study process but not determine the factors that need to be changed.	Evaluation of the self-study process is not accurate, and the factors that need to be changed have not been drawn.

The results of the assessment on the worksheets and students' self-assessment cards are shown in the chart:
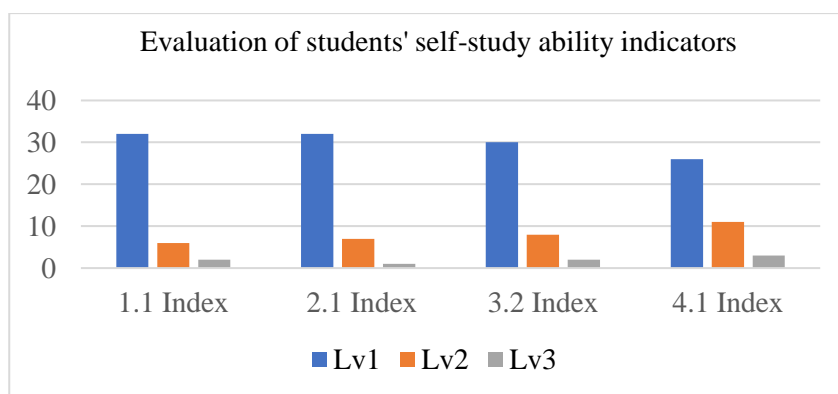
Figure 9. Assessment results of students' self-study ability indicators

The chart above shows that, in most of the indicators, more than 60% of students in the class achieved level 1 and the number of students achieving level 3 only accounted for less than 10%. The self-study ability index is converted to the maximum score of 10, the class average grade is 8.1, and the Std. The deviation is 1.8, showing that the students' self-study ability is quite good. Demonstrating the VL-AI Chatbot in education helps students clearly define the goals and content of the lesson. Students learn about Chatbot VL-AI and easily apply it, thereby interacting with Chatbot VL-AI to solve problems effectively.

The use of Chatbot VL-AI helps students self-study at home and are self-assessed by questionnaire. Assessment results are classified according to the respective levels and scores: level 4 (very good), level 3 (good), level 2 (normal), level 1 (not good).

Table 3. Student feedback on the effectiveness of Chatbot VL-AI in the self-study process

Manifestation	Level 4	Level 3	Level 2	Level 1	Average
How easy is it to use Chatbot VL-AI?	37	2	1	0	3.83
VL-AI Chatbot helps identify learning goals.	33	5	2	0	3.76
Chatbot VL-AI helps build effective learning plans.	30	7	3	1	3.68
Chatbot VL-AI helps to learn the lesson content.	32	5	2	1	3.70
Rate the Relevance of using Chatbot VL-AI in other lessons.	31	6	2	1	3.68

The results of the students' opinions show that the average score of each expression is above the good level. Up to 92.5% rate the use of Chatbot VL-AI as easy because students interact with Chatbot VL-AI by texting or exchanging lessons with friends. Through the direct feedback of students when studying, the majority believe that when using the VL-AI Chatbot, the self-study process at home is more effective, understanding the lesson more deeply than reading the material by yourself. Chatbot VL-AI is like replacing the teacher when suggesting students learn new problems more easily and conveniently. In addition, students also have some ideas in the process of using Chatbot VL-AI: (1) can give more experiments to observe more phenomena; (2) needs to be applied to more articles; (3) can add exercises to apply knowledge of momentum; (4) need more materials about Chatbot, expand knowledge for other parts.

The above comments all show that the use of Chatbot is necessary and should be built continuously into chapters, contents, and subjects so that students can be supported better in self-study.

3. Conclusion

Through learning about Chatbot and its application, Chatbot has tremendous potential for use in education. In this study, we used a Chatbot in physics teaching called Chatbot VL-AI to bring indicators of self-learning ability and the teaching process to foster it when using Chatbot VL-AI to apply in building lectures based on Chatbot VL-AI. We analyzed the content of knowledge to gain momentum, from which to come up with the idea of designing lessons and training the VL-AI Chatbot according to the built scenario.

Experimenting with 10th-grade students at High School for Gifted Students of VNU University of Sciences shows the feasibility and effectiveness of this method, contributing to strengthening the awareness that Chatbots can be used in teaching. However, the research stopped at testing on some classes at specialized schools, we will continue to expand the scope of the experiment, research more teaching techniques with Chatbot and build more lectures of other knowledge to perfect Chatbot VL-AI in particular and develop Chatbot in general in teaching.

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