

## DESIGN AND USE OF LEARNING MATERIALS TO ENHANCE STUDENTS' LEARNING INTEREST IN GRADE 10 CHEMISTRY

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**Abstract.** Interest plays an important role in improving the learning efficiency of the teaching process. The 10th-grade chemistry subject of The New General Education Curriculum is designed with a multitude of changes in terms of content, layout, and presentation form, which attract readers and meet the program's requirements. To further promote creativity and increase learners' interest, one innovative approach is the design and use of learning materials such as comic books, and videos that provide some knowledge of the lesson, games that require students to solve learning tasks, and worksheets that enhance students' interest in learning chemistry. This article gives examples of learning materials designed and used in some 10th-grade chemistry lessons as well as a questionnaire to identify students' interest in learning chemistry through three basic signals: emotion, cognition, and action. The results of pedagogical experiments show that the use of these learning materials is effective in promoting interest in learning for students studying 10th-grade chemistry. This study can be a reference for teachers in applying technology to build learning materials and visual aids to enhance learners' interest in chemistry. Most notably, teachers and students can quantitatively assess learners' interests through questionnaires in terms of emotion, cognition, and action.

**Keywords:** learning materials, learning interest, chemistry teaching, Vietnam Chemistry Curriculum.

## 1. Introduction

Developing an interest in learning in general and chemistry, in particular, is one of the key goals of education in some countries. Thus, over the years, this field has fuelled many studies. In addition to focusing on getting high grades and developing the qualities and competencies of students, cultivating an interest in learning also makes students more likely to go to class, pay attention, become engaged, and create a happy learning environment.

Learning materials are physical means of storing, carrying, or reflecting learning and research content that teachers can use in teaching and learning situations to help achieve desired

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learning goals. Learning materials that are appealing to students can make learning more interesting, engaging, and interactive. Learning materials can be used in both traditional forms (pictures, cards) and e-learning materials.

Many measures have been applied to increase the interest of learners and some results have been achieved. Judith M. Harackiewicz et al. [1] illustrated four interest-enhancing interventions: attention-getting settings, contexts evoking prior individual interest, problem-based learning, and enhanced utility value. These interventions have contributed to a more engaged, motivated, learning experience for students. Avi Hofstein<sup>1</sup> and Rachel Mamlok-Naaman [2] have suggested three key factors that should be considered for enhancing attitudes and interests: the methods used to present the content, instructional techniques, and gender issues. They believe these factors should be considered by educators, curriculum developers, and chemistry teachers who believe that developing a positive attitude is one of the central goals.

In Vietnam, Thai Hoai Minh and Nguyen Minh Tuan [3] applied augmented reality technology in teaching chemistry to increase students' interest. The authors designed a questionnaire about the level of students' interest in 5 levels and assessed them through emotional and action expressions. The results obtained are very positive. Dao Thi Hoang Hoa [4] studied the attitudes of high school chemistry students in Ho Chi Minh City from teachers' perspective and found that students' attitudes towards the subject can be one of the deciding factors that determine the effectiveness of studying the subject and a student's choice of subject in the national exam. In fact, in recent years, the number of students choosing chemistry as an elective subject in many high schools has decreased. The reason for this is that the entrance requirements of many majors of many universities do not include chemistry as a subject for admission. In addition, some chemistry teachers think that The New General Education Curriculum [5] with some new content such as the nomenclature of elements and compounds is difficult to pronounce and remember. Also, some content is supplemented such as thermodynamics, and some content of chemical bonding can make it difficult for teachers to design lessons to increase learning interest for students. This may cause difficulties in teaching and learning for teachers and students and will reduce students' interest and desire to study chemistry. In this paper, learning materials have been designed and used in 10th-grade chemistry of The New General Education Curriculum to increase student interest. The new materials excite students, create interest in chemistry, and make it easier to learn chemistry. In addition, the questionnaire is designed to assess the level of interest of students in the lessons.

## **2. Content**

### **2.1. Interest and learning interest**

According to [6], [7] "Interest is an individual's special attitude towards an object, which has to mean both in life and the capability of bringing pleasure to the individual in the process of the activity". According to [8] "Interest is an individual's particular attitude towards some objects that are both meaningful in life and bring personal pleasure in activities". Thus, an individual's interest in an object means that the individual has a positive and proactive attitude toward that object, which is expressed in attention to the object and a wish to learn deeply about that object.

Interest plays a particularly important role in life. According to [6], and [9], Interest increases sensitivity and insight, thereby increasing the effectiveness of the cognitive process because when interested, the individual focuses on the object to reflect that object well. In the learning process, interest in learning helps students to be proactive, and enhances the efficiency of the cognitive process, increasing the frequency and intensity of emotions, cognition as well and actions of students in the learning process. It also makes the processes of feeling, perception, memory,

imagination, and thinking more focused and efficient. Thus, interest brings excitement and enjoyment to individuals in activities and the design of learning materials helps to increase learning excitement for students and contribute to improving students' learning outcomes.

According to [3] student interest in learning chemistry is grouped in three basic categories: emotion, cognition, and action. In terms of cognition, students are aware of the role, importance, and meaning of chemistry in life and themselves. In terms of action, students demonstrate positivity, initiative, and creativity in and out of class related to chemistry. In terms of emotion, students show excitement, joy, satisfaction, and happiness when they learn chemistry

Emotion, cognition, and action were rated at different levels designed on a Likert scale (levels from 1 to 5) [10] shown in Tables 1, 2, and 3.

## **2.2. Survey results of some teachers applying some learning materials to enhance students' learning interest in teaching Chemistry**

Seventy-four chemistry teachers (survey link: <https://forms.gle/yWV4X99g2CnaYBCS9>) and 122 students (survey link: <https://forms.gle/V4Kag1NiQmtbm8rG8>) from 10 high schools in 6 provinces and cities participated in the online and paper-distributed survey between October 2022 and December 2022. The survey results were analyzed using Excel software. The investigation was carried out through questionnaires about the current situation of teaching 10th-grade chemistry under the General Curriculum of Chemistry in 2018, the level of interest of students in chemistry lessons, and methods to improve students' interest in learning chemistry. Questionnaires were sent to teachers and students in both paper and online form, including questions designed on a Likert scale (levels from 1 to 5) [10] and several multiple-choice questions and constructed responses. The questionnaire also asked about the level of materials used in teaching chemistry in grade 10 according to the General Curriculum of Chemistry.

The results show that the students' interest in learning chemistry when assessed by a teacher averaged 3.43/5 (the average score is 3.43/5) and the student self-assessed level averaged 3.43/5 (3.43/5). That is the moderate level. The surveyed students also reported that the average likeability factor for chemistry was 3.39, the level of constructive participation in learning activities during class time was 3.18/5, and their time for chemistry self-study at home was 2.99/5 even though chemistry was their elective subject. Students said chemistry is a dry subject and their teachers have not organized many learning activities that use visual aids, experiments, or games for learning. The students surveyed said that they very much want their chemistry teachers to apply a variety of visual aids, chemistry experiments, information technology, and films to their chemistry teaching. They said they wanted the change to experience new technology, increase learning interest, and make lessons easier to understand.

Most teachers think that it is very important to improve students' interest in learning chemistry (the average score is 4.69/5). They also think that the difficulty level of 10th-grade chemistry in the General Curriculum is 3.65/5 compared to the previous school chemistry curriculum. They cite the almost complete overhaul of the curriculum including the use of English for the names of elements and compounds. The new curriculum requires developing learners' competence towards output standard results and being student-centered, reducing the number of exercises with multiple calculations and away from reality theoretical questions with no practical application. While it is important to introduce active teaching methods and information technology, many teachers struggle with modern teaching methods. Curriculum innovation requires innovation in teaching methods, but many teachers still use traditional teaching methods such as presentations. Thus, it is very important to have guidelines for the development and use of learning materials (the average score is 4.39/5). There are a variety of measures that the teachers

surveyed took to increase the chemistry learning interest among their students, such as using chemistry experiments and games, applying information technology in their lessons, and including practical information in lessons as well as applying knowledge of chemistry to explain natural phenomena. However, these methods are not used very often, most still use methods such as presentations. Finally, most of the teachers surveyed said that if there were specific guidelines for improving students' interest in learning chemistry, they would be ready to change teaching methods to achieve their goals (the average score is 4.46/5).

### **2.3. Design and use of learning materials help enhance students' learning interest in teaching Chemistry in grade 10**

Some measures to increase the interest in chemistry, and the principles of building learning materials as well as using these methods in teaching chemistry have been presented in several documents [3], [11], [12]. In this study, we designed some learning materials based on some construction principles referenced in those documents such as methods of designing learning materials (Information videos, questionnaires, flashcards, comics) and tools to estimate student interest (questionnaires). However, we have developed them at a deeper level (There are two versions in Vietnamese and English, with worksheets categorized by levels from easy to difficult), and made adjustments to suit the content and requirements of the General Curriculum of Chemistry in 2018. Some games not only require knowledge but also require agility (shown in the game Bees Looking for a Nest), proficiency in information technology, and teamwork skills (shown in the game Puzzle Game). Some learning materials are designed in the form of games like many games in entertainment programs on television such as "Ai la trieu phu", "Chiec non ki dieu", and "Duong len dinh Olympia". Students enjoy participating in, the games and feel comfortable and motivated to try to complete the task and become winners.

*Table 1. The learning materials built for the lessons*

No.	The name of the lessons	Learning materials designed	Purpose
1	Lesson 9: Octet Rule	Designing a video to introduce the octet rule, and why elements tend to exhibit the octet rule when participating in chemical bonds.	Boost your students' attention and interest in the lesson by opening with a lively video.
2	Lesson 10: Ionic Bonding	Describe in an easy-to-understand way the formation of an ionic bond between two atoms.	Make it easy for students to imagine the formation of a bond between two atoms through descriptions in the form of videos that help them see learning like watching a short film.
3	Lesson 11: Covalent Bond	Explain the formation of a covalent bond between two atoms.	
4	Lesson 17: Halogen Elements	Design a video summarizing the properties of halogens.	Help students summarize what they have learned.
5	Topic 3: Chemical Bond	Design learning worksheets.	Help students actively participate in learning activities individually or participate in group activities.
6	Topic 7: Halogen Group	Design learning worksheets.	

7	Topic 3: Chemical Bond	Design learning content in the form of comics.	Provide knowledge, introduce new knowledge content, and review learned knowledge.
8	Topic 7: Halogen Group		
9	Topic 7: Halogen Group	Design learning games like games in some entertainment programs.	Gives students the feeling of discovering and conquering knowledge on their own, which makes learning like participating in a game.

### 2.3.1. Design videos containing lesson information for warm-up activities

Videos with information related to the lesson are a common format used by teachers for warm-up activities, knowledge consolidation, or practice. These videos are built based on the content of the lesson, learning goals, levels, and interests of students. For example, for warm-up purposes, these videos usually last from 2 to 3 minutes to present problem situations or provide some information related to the lesson. This stimulates students' curiosity and exploration, making them interested in finding the answer to the problem posed by the video. Teachers also need to consider students' levels and interests to create videos that can attract their interest. The video should not be too easy too difficult, or boring. Elements such as sound and visual effects should also be considered to suit the age of the students. Usually, these videos are short and provide key information related to the topic or knowledge to be covered. Students apply what they have learned from the videos to give predictive answers about the content being talked about or solve learning tasks. Videos can help s to change the classroom and make the academic atmosphere fun and exciting, thereby contributing to increasing students' positivity. Based on the intended use, teachers can build appropriate video content.

*\* The method uses video to provide some information about the halogens for the warm-up activity*

**Objective:** Stimulate students' interest and curiosity through the information in the video. Students identify applications, physical properties, and characteristic chemical properties of halogen group elements.

**Content:** Before going to lesson 17, the teacher provided a short film about a conversation between halogen elements. Halogen elements argue with each other about their applications and properties. After the students finished watching the video, the teacher asked them students to work individually and answer the questions in the worksheet about the application, and physical and chemical properties of halogens.

**Products:** Students would be able to present the physical properties, chemical properties, and applications of halogen elements.

**Implementation organization:** The teacher shows the video and asks the students to complete the learning task. Students work individually and in group discussions, making their own predictions. The link to this video: <https://www.youtube.com/watch?v=U0Rt7bLyq4s>

*\* Some other informative videos are designed for warm-up, consolidation, and expansion activities or during practice sessions*

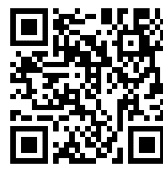
Some of these videos are for different purposes depending on the content, requirements, and objectives of the lessons. These videos are given as QR codes (see Fig.1).



a. The trend of changing the physical properties of the halogens



b. Ionic bonding



c. Halogen elements introduction



d. Halogen elements properties

Figure 1. Some videos contain information used for different learning purposes

### 2.3.2. Design worksheets for specific learning contents

Worksheets are one of the common teaching tools used. However, the worksheets being used no longer attract students' interest. Some changes in design, style, and content are necessary. Worksheets should satisfy the following criteria: have enough information; be creative, lively, create interest for students; and have a scientific and logical design.

#### \* Using worksheets for new knowledge formation activities

Objective: Through several Q&A activities, presentations, and learning lessons, students need to: describe the state, color, melting point, and boiling point of halogen elements.

Content: Students study the knowledge in the textbook and the information provided by the teacher and complete the worksheet to achieve the learning goal.

Products: Students complete the questions on the worksheet to achieve the lesson objectives.

Implementation organization: The teacher distributes worksheets to students, asks students to work individually to complete the questions in the worksheet, and then students to express their opinions. Finally, the teacher comments, supplements, and summarizes (see Fig.2).

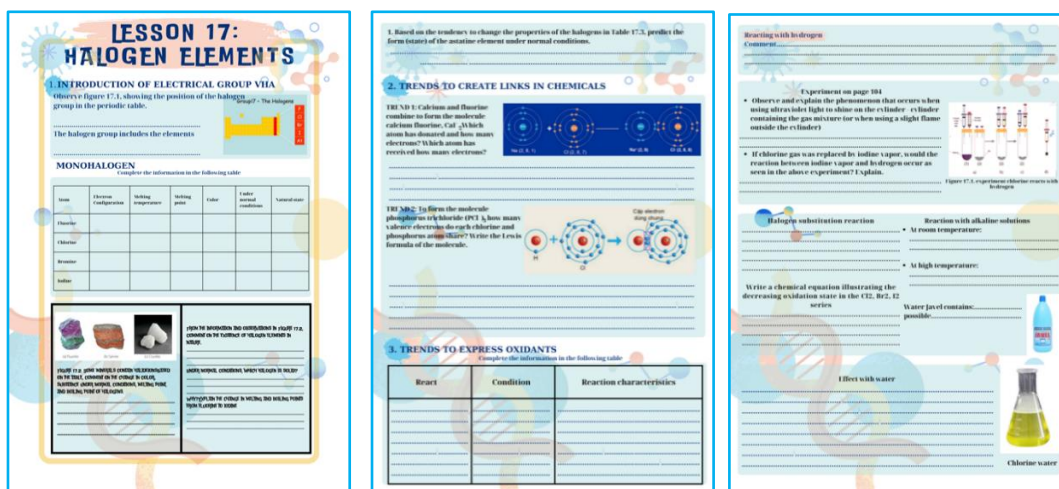


Figure 2. Some worksheets in "Lesson 17: Halogen Elements" were used for knowledge formation activities

Some worksheets are designed for warm-up, consolidation, and expansion activities or during practice sessions are shown in Figs. 3 and 4.

**BÀI 18**  
HYDROGEN HALIDE AND HYDROHALIC ACID

**I. HYDROGEN HALIDE AND HYDROHALIC ACID**

**1. Hydrogen halide**

- Explain why the polarity of HX molecules decreases from HI to HF.

Based on the table below, indicate which hydrogen halide gas will liquefy first when the temperature is lowered.

Hydrogen fluoride (HF)	19.5
Hydrogen chloride (HCl)	-84.9
Hydrogen bromide (HBr)	-66.7
Hydrogen iodide (HI)	-35.8

- Are hydrogen halides readily soluble in water? Why?

**2. Hydrohalic acid**

- Acidity of solutions of HX ..... according to the sequence from HI to HCl
- What is the main cause of increased strength of acids?

**II. ELIMINATION OF SOME HALIDE IONS**

- Which compounds containing Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup> ions have in common? And what is the difference?
- Is the reaction of solid sodium iodide with concentrated sulfuric acid a redox reaction? Why?
- Can hydrogen bromide be prepared from the reaction of potassium bromide with concentrated, heated sulfuric acid? Why?

**III. APPLICATION OF HYDROGEN HALIDE**

**1. Application of hydrogen fluoride**

- How is the application of HF in practice?

**2. Application of hydrogen chloride**

- If the cylinder water is slowly injected to the end of the cylinder containing hydrogen chloride gas, what will happen?

**IV. DISCLAIMER HALIDE IONS**

For solutions: NaF, NaCl, NaBr, NaI react with silver nitrate. How to distinguish which is a solution: NaF, NaCl, NaBr, NaI

Figure 3. Some worksheets in "Lesson 18: Hydrogen Halide and Hydrohalic Acid" were used for knowledge-formation activities

**Lesson 16:**  
**CHEMICAL REACTION RATE**

Put two pieces of Mg of the same mass into two test tubes containing the same volume of excess HCl solution, the concentration of HCl solution in each test tube is 2M and 0.9M respectively. In your opinion, which test tube Mg fragment will dissolve completely before? Explain.

**I. THE CONCEPT OF THE REACTION RATE, THE AVERAGE RATE OF THE REACTION**

**\*Concepts**

Reaction rate: \_\_\_\_\_ Unit: \_\_\_\_\_

Sign: \_\_\_\_\_

**\*Average rate of reaction**

Average rate of reaction: \_\_\_\_\_ Unit: \_\_\_\_\_

Formula: \_\_\_\_\_

For decomposition reaction:  $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$

Time (s)	$V_{\text{H}_2}$ (ml)	$V_{\text{O}_2}$ (ml)
0	0	0
10	10	5
20	20	10
30	30	15
40	40	20
50	50	25

Average rate of reaction in O<sub>2</sub> for the first 100 seconds.

From Table 16.1, can the average rate of the reaction be calculated after 30 seconds? Why?

**II. Law of Mass Effect**

Law of mass action: \_\_\_\_\_ Sign: \_\_\_\_\_

Unit: \_\_\_\_\_

Formula: \_\_\_\_\_ The reaction rate constant is exactly equal to the reaction rate when: \_\_\_\_\_

- Food goes rancid due to oxidizing reactions of oxygen as well as bacterial activity. Explain why to limit rancidity, people inject N<sub>2</sub> or CO<sub>2</sub> into food bags before packaging. Know that the oxygen concentration in the food bag after pumping N<sub>2</sub> or CO<sub>2</sub> is only about 2-3%.
- In the following reaction, if the concentration of I<sub>2</sub> is doubled, then how does the reaction rate change?  $\text{H}_2 \text{ (g)} + \text{I}_2 \text{ (g)} \rightarrow 2\text{HI} \text{ (g)}$

**III. FACTORS AFFECTING REACTION RATE, VAN'T HOFF TEMPERATURE COEFFICIENT**

**\*The effect of concentration**

- When the concentrations of H<sub>2</sub> or I<sub>2</sub> are doubled, the rate of reaction of H<sub>2</sub> with I<sub>2</sub> \_\_\_\_\_
- Effect of concentration on the rate of reaction: \_\_\_\_\_

**\*Effect of pressure**

- Why do people use pressure cookers when cooking to cook faster?
- Effect of pressure on the rate of reaction: \_\_\_\_\_
- Effect of pressure on surface area: \_\_\_\_\_
- Which gas can be released more?
- Effect of surface area on reaction rate: \_\_\_\_\_

**\*Effect of temperature**

- Why does food go rancid more slowly when stored in the refrigerator?
- The effect of temperature on the reaction rate: \_\_\_\_\_
- The relationship between van't Hoff coefficient and temperature: \_\_\_\_\_

**\*The influence of catalysts**

The effect of a catalyst on the rate of reaction: \_\_\_\_\_

Why do people add lactic yeast when making yogurt?

Figure 4. Some worksheets in "Lesson 16: Chemical Reaction Rates" were used for knowledge-formation activities

2.3.3. Design comics for teaching stages

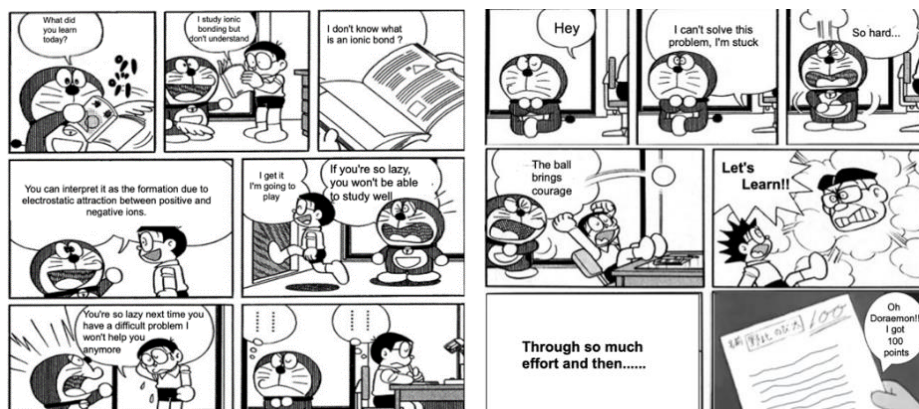


Figure 5. Some comics in the lesson "Ionic Bond" were used for knowledge formation activities



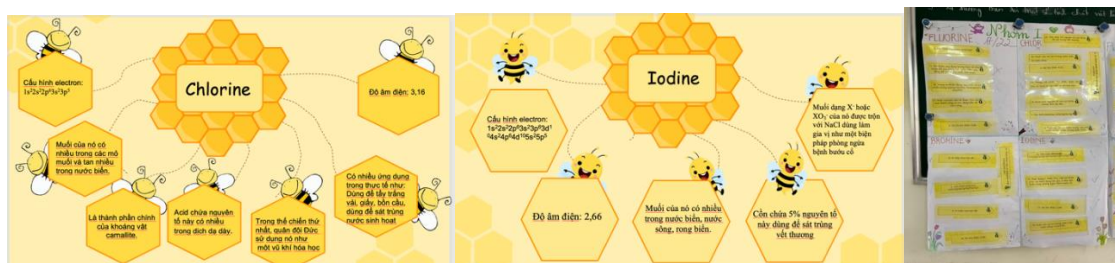


Figure 7. Some pictures of the game “Bees Looking for a Nest” in teaching lesson 17: Halogen Elements



Figure 8. Some pictures of students participating in this game and its products

\* Using games “Puzzle Game” for lesson review activities in teaching lesson 17: Halogen Elements

**Objective:** Systematize the content of the key knowledge learned about the tendency to change the physical properties of the halogens.

**Content:** Students participate in the game "Puzzle Game", choosing knowledge content with appropriate keywords to form a complete picture.

**Products:** A complete flower with each puzzle piece containing the content of knowledge sorted into the correct keywords.

**Implementation organization:** The teacher divides the class into 4 groups. Introduce the rules of the game and ask the groups to complete the task within the allotted time (10 minutes). The group that completes the task in the shortest time, matches the information with the correct keywords and forms the most beautiful flower will win. This game is shown in Fig. 9.

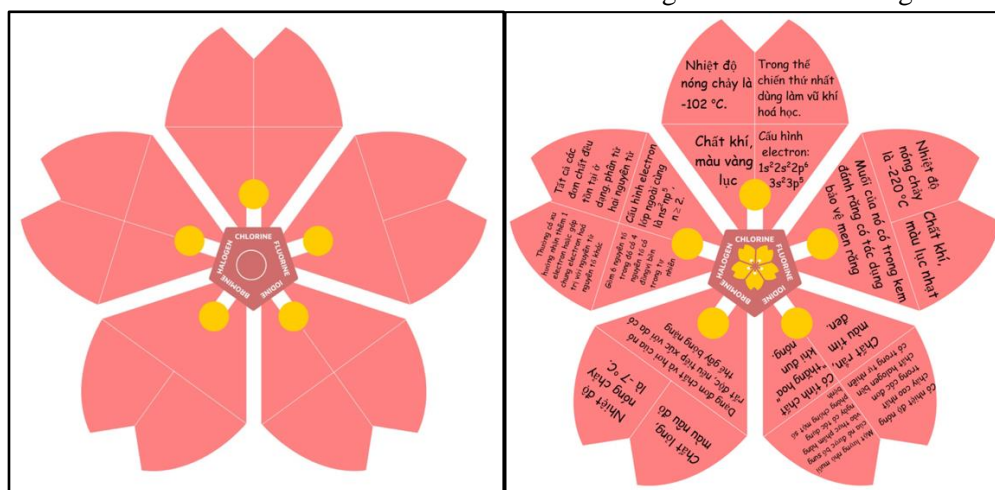


Figure 9. Some pictures of the game “Puzzle Game”

*in teaching "Lesson 18: Hydrogen halide and Hydrohalic acid"*

\* Some games are used for lesson reinforcement or warm-up activities

Teachers can design some games such as "Vuot Chuong Ngai Vat", "Tang Toc" or "Who Am I". Some illustrations for these games are shown in the images below:



**Figure 10.** Some pictures of game "Vuot Chuong Ngai Vat" in teaching "Lesson 17: Halogen elements"



**Figure 11.** Some pictures of the game "Who Am I" in teaching "Lesson 17: Halogen Elements"

## 2.4. Pedagogical experiments

### 2.4.1. Location, objects, and content of pedagogical experimentation

To evaluate the feasibility and effectiveness of applying some learning materials to heighten students' learning interest in teaching chemistry in grade 10, we conducted a pedagogical experiment at the Thanh Mien High School in Thanh Mien district, Hai Duong province. The pedagogical experiment period was from September 2022 to April 2023. The selected pedagogical experimental subjects were 39 students of class 10I - experimental class and 45 students of class 10K - control class.

We choose pedagogical experiments with five designed learning materials including Products "Game bees find the Hive", "Puzzle Game", and "Vuot Chuong. Ngai Vat" in teaching lesson 17 "Nguyên tố và đơn chất halogen"; products "Comic Design", "learning worksheets", and "videos design" in teaching lesson 10 "Liên kết ion". We used these learning materials to increase students' learning interest which is expressed in three expression groups: emotions, cognition, and actions.

The assessment of students' learning interests in two experimental and control classes for Chemistry 10 was done through a student self-assessment questionnaire with groups of expressions of learning interest that we built above. The process of pedagogical experimentation for the experimental class and the control class is shown in Table 2.

### 2.4.2. Results of pedagogical experiments

Expressions of students in terms of emotions, cognitions, and actions are determined based on the student's self-assessment of the degree of agreement with these expressions when completing some content in chemistry subject in 10th grade. Self-assessment results are converted on a Likert scale of 1 to 5 points corresponding to 5 levels (Level 1 – Strongly disagree; Level 2 – Disagree; Level 3 – Normal; Level 4 – Agree; Level 5 – Strongly agree) to calculate the average score of each expression and determine the average of the expressions before and after the experiment. These questionnaires were distributed to students to self-assess their level of interest in the pre-experiment and after-experiment chemistry lessons in both experimental and control

classes. Before the experiment, teachers did not use learning materials in both experimental and control classes. Students' interests were expressed in terms of emotion, cognition, and actions. Students' interest in terms of action is expressed in 9 criteria. If students are excited about the lesson, they will spend more time preparing the lesson before going to class, the time they spend on self-study at home also increases, and when participating in lessons they pay attention. They also take full notes, actively ask questions to class members and teachers, and they also tend to complete homework assignments. In addition, they are excited to discuss knowledge together outside the classroom and learn more knowledge on websites, references, or newspapers. The obtained results are processed in Excel and are shown in Tables 3 - 4.

**Table 2. Description of the pedagogical experimental process for the experimental class and the control class**

Experimental time	Pedagogical experimental process	The experimental class	The control class
<i>Before experiment</i>	Implement the lesson plan for lesson 1, lesson 2, and lesson 4 in the 10th-grade chemistry textbook "Canh Dieu" which mainly used traditional teaching methods such as presentation method and method evocative conversational methods in the experimental class and the control class. Students then state their level of interest in learning 10th-grade chemistry through the designed interest level questionnaire.		
<i>During experiment</i>	1. Pedagogical experiment for lesson 17 "Nguyên tố và đơn chất halogen" (Section 2)	Producing activities like "Game bees find the hive" helps students review their lessons.	The teaching plan is similar to the experimental class, replacing activities using learning materials with traditional teaching activities such as presentation and conversation methods.
	2. Pedagogical experiment for lesson 17 "Nguyên tố và đơn chất halogen" (Section 2)	Producing activities like "Puzzle Game" helps summarize the lesson on "Nguyên tố và đơn chất halogen".	
	3. Pedagogical experiment for lesson 17 "Nguyên tố và đơn chất halogen" (Section 3)	Producing activities like "Vuot Chuong Ngai Vat" for new knowledge-forming activity (the strong oxidizing property of chlorine)	
	4. Pedagogical experiment for lesson 17 "Nguyên tố và đơn chất halogen" (Section 2)	Producing activities like "Vuot Chuong Ngai Vat" helps students review their lessons.	
	5. Pedagogical experiment for lesson 10 "Lien Ket Ion"	Use worksheets, comics, and videos for new knowledge-forming activities and review the lesson.	
	6. Pedagogical experiment for lesson 10 "Lien Ket Cong hoa tri"		
<i>Get feedback after the experiment</i>	After finishing the experiment with several teaching activities in the control and experimental classes, we distributed questionnaires to get students' feedback on their level of interest in learning and the ability to receive and remember their knowledge.	Perform	Do not perform

**Table 3. Results of student's self-assessment of interest in learning**

Ordinal Number	Expressions	Control Class – 10K		Experiment Class – 10I	
		Before experiment	After experiment	Before experiment	Before experiment
<b>The expressions in terms of emotions</b>					
1	Feel excited when it is time to start the lessons	3.16	3.27	2.95	3.59
2	Feel happy and comfortable in the lesson	3.13	3.62	3.15	4.51
3	Feel excited when completing a learning task	2.91	2.96	3.10	3.97
<i>The average score</i>		<i>3.07</i>	<i>3.28</i>	<i>3.07</i>	<i>4.03</i>
<i>Mode</i>				<i>3.33</i>	<i>3.67</i>
<i>Median</i>				<i>3.00</i>	<i>4.00</i>
<i>Mean</i>				<i>3.07</i>	<i>4.03</i>
<i>Standard deviation</i>				<i>0.52</i>	<i>0.44</i>
<i>Pair test T-test</i>				<i>3.78x10<sup>-13</sup></i>	
<i>Level of influence ES</i>				<i>1.84</i>	
<b>The expressions in terms of cognition</b>					
1	Learning chemistry helps to explain many phenomena in reality	3.58	3.62	3.46	4.23
2	The knowledge of chemistry has many applications in life	3.42	3.42	3.21	4.00
3	Chemistry has an important role in the development of students' capabilities	2.89	3.38	2.72	3.90
4	Learning chemistry is necessary for high school students	3.09	3.44	2.64	4.15
<i>The average score</i>		<i>3.24</i>	<i>3.47</i>	<i>3.01</i>	<i>4.07</i>
<i>Mode</i>				<i>3</i>	<i>4.25</i>
<i>Median</i>				<i>3</i>	<i>4.25</i>
<i>Mean</i>				<i>3.01</i>	<i>4.07</i>
<i>Standard deviation</i>				<i>0.52</i>	<i>0.44</i>
<i>Pair test T-test</i>				<i>3.38x10<sup>-28</sup></i>	
<i>Level of influence ES</i>				<i>3.39</i>	
<b>The expressions in terms of action</b>					
1	Prepare lessons before lesson time	3.44	3.60	3.33	4.05
2	Self-study at home	3.62	3.87	2.92	3.51
3	Pay attention in class	4.22	4.29	3.79	4.36
4	Take full notes	3.96	4.07	3.69	4.05
5	Express proactively opinions and ask questions	3.42	3.58	3.13	3.95
6	Participate actively in learning activities	3.44	3.64	3.46	4.28
7	Complete homework	3.51	3.56	3.54	3.90
8	Compile, record, and accumulate documents from many sources	2.98	2.98	2.82	3.46

9	Discuss chemistry subjects outside of class time	2.98	3.27	2.49	3.23
<i>The average score</i>		3.51	3.65	3.24	3.87
<i>Mode</i>				3.22	3.78
<i>Median</i>				3.22	3.89
<i>Mean</i>				3.24	3.87
<i>Standard deviation</i>				0.15	0.17
<i>Pair test T-test</i>				$1.4 \times 10^{-27}$	
<i>Level of influence ES</i>				4.2	

**Table 4. Compare the results after the experiment between the experimental class and the control class**

	The expressions in terms of emotion		The expressions in terms of cognition		The expressions in terms of action	
	<i>Control Class</i>	<i>Experiment Class</i>	<i>Control Class</i>	<i>Experiment Class</i>	<i>Control Class</i>	<i>Experiment Class</i>
<i>Mode</i>	3.33	3.67	3.5	4.25	3.67	3.78
<i>Median</i>	3.33	4.00	3.5	4.25	3.67	3.89
<i>Mean</i>	3.28	4.03	3.47	4.07	3.65	3.87
<i>Standard deviation</i>	0.43	0.44	0.25	0.27	0.15	0.17
<i>Pair test T-test (p)</i>	$1.81 \times 10^{-11}$		$8.67 \times 10^{-6}$		$1.66 \times 10^{-8}$	
<i>Level of influence ES</i>	1.7		2.22		1.29	

The results show that the level of interest of students when learning lessons without using learning materials (before the experiment) in the experimental and control classes is similar. After the experiment, the results showed that the students' interest in the experimental class was higher than the control class and the scores in the control class before and after the experiment were not much different. This proves that the use of learning materials has a positive impact on students' learning interests.

Experimental results show that after applying some learning materials to teaching some content of grade 10 chemistry, the interest in chemistry learning of experimental grade students is increased. The ES value from the evaluation questionnaire of the students shows that the application of some learning materials in teaching grade 10 chemistry has a great influence on the increase of the learning interest of the students. To test the influence of the common mean differences in the two groups, we also conducted an independent T-test and a dependent T-Test. The p-value in the independent T-Test after the impact between the two groups in terms of emotion, cognition, and action is less than 0.05. This has proven that the difference in the overall mean score after the effect between the two groups is significant, in favor of the experimental class (10I).

With the T-Test of dependence between before and after the experiment of class 10I, the obtained p values are also less than 0,05. This shows that the obtained data is reliable, and the project is significant in enhancing the interest of students. This project also confirms the effectiveness of the application of learning materials in teaching 10th-grade chemistry, which increases students' interest in learning.

**\* Feedback from experimental class students**

After the experiment, we collected students' opinions on their level of interest when participating in chemistry lessons using learning materials in the form of direct distribution of questionnaires, and an online survey by accessing the Menti.com app to participate in the games. The results obtained from the survey are shown in Figure 11.



**Figure 11. Some pictures of the game “Who Am I” in teaching “Lesson 17: Halogen Elements”**

The survey results from the direct answer sheets show that the level of interest of students in chemistry lessons using chemical materials is very high (the average score is 4.39/5). When surveyed on Menti.com the keywords 'Interested', 'Fun', 'Interesting', and 'Excited' were the most repeated. Besides, the students also think that the application of learning materials in the lesson makes it easier for them to absorb knowledge, remember the lesson well, and understand the lesson more easily.

### 3. Conclusions

It is very necessary to improve students' learning interest in teaching chemistry in grade 10 according to the General Curriculum of Chemistry because it contributes to meeting the training requirements of The New General Education Curriculum in Vietnam. When designing learning materials, teachers need to base them on the lesson objectives, students' abilities, and the number of students in each group to design learning materials suitable to the organization of teaching activities (for individual or group discussion). In addition, some learning materials require classrooms to be equipped with equipment such as televisions or computers with an Internet connection and projectors, so teachers also need to base lessons and materials on the physical conditions of each class to design learning materials that are effective and suitable for each lesson's content. Teachers also need to base the material on the content of knowledge in textbooks to design and apply each type of learning material appropriately. The results of pedagogical experiments show that the application of learning materials in teaching 10th-grade chemistry can enhance students' learning interest in terms of emotion, cognition, and action. This shows the effectiveness and feasibility of the teaching approach used in this project to improve students' interest in learning.

### REFERENCES

[1] Judith M. Harackiewicz, Jessi L. Smith, and Stacy J. Prinisk, 2016. Interest Matters: The Importance of Promoting Interest in Education. Policy Insights Behavioral Brain Science. Published online 2016 Jun 30. pp. 220-227. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5839644/>.

- [2] Avi Hofstein<sup>1</sup>, Rachel Mamlok-Naaman, 2011. High-school students' attitudes toward and interest in learning Chemistry. *Education Quismica*. DOI: 10.1016/S0187-893X(18)30121-6, pp. 90-102.
- [3] Thai Hoa Minh, Nguyen Minh Tuan, 2020. Applying augmented reality technology to improve students' learning interest in teaching high school grade 11 Organic Chemistry content. *Ho Chi Minh City University of Education Journal of Science*. ISSN: 1859-3100. Vol. 17, No. 11, pp. 1970-1983 (in Vietnamese).
- [4] Dao Thi Hoang Hoa, 2015. Students' attitude towards the subject Chemistry from the perspective of Chemistry teachers. *Ho Chi Minh City University of Education Journal of Science*, pp. 32-38 (in Vietnamese).
- [5] Vietnam Ministry of Education and Training, 2018. General Education Program, Hanoi.
- [6] Hoang, Phe, 2012. *Vietnamese dictionary*. Hanoi: Vietnam Encyclopedia Publishing House.
- [7] Nguyen Quang Uan, 2017. *General Psychology*: Vietnam National University Press, Hanoi, p.173 (in Vietnamese).
- [8] Le Thi Han, Huynh Van Son, 2012. *General Psychology Textbook*. Ho Chi Minh City University of Education Publisher, p. 196 (in Vietnamese).
- [9] Pham, N. T., 2011. Suggesting some motivational measures in teaching and learning chemistry at secondary high schools. *Ho Chi Minh City University of Education Journal of Science*, 7, pp. 109-114.
- [10] Likert, R, 1932. A Technique for the Measurement of Attitudes. *Archives of Psychology*, 140, pp. 1-55.
- [11] Pham Ngoc Thuy, 2008. Measures to create excitement in teaching chemistry in high schools. Master's Thesis in Education. Ho Chi Minh City University of Education.
- [12] Pham Thi Thanh Truc, 2013. Some measures to create interest in studying chemistry in grade 10 in high schools. Ho Chi Minh City University of Education, pp. 28-84 (in Vietnamese).