

# APPLICATION OF 5E MODEL IN NATURAL SCIENCE TEACHING TO DEVELOP STUDENTS' NATURE-UNDERSTANDING COMPETENCE IN JUNIOR HIGH SCHOOL

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## Abstract

According to the Natural Science Curriculum 2018, nature-understanding competence is one of the three components of natural scientific competence. The expression of this competence is that students can perform some basic skills to understand and explain natural phenomena, demonstrating practical problems with scientific evidence. An important feature of teaching Natural Science is that students need to experience and discover things and phenomena of the natural through experiments and practical experiences, thereby forming scientific knowledge and apply knowledge to solve problems in life. The 5E is a model of science teaching in accordance with the educational philosophy of "student-centered" and is built on the theory of constructivist teaching, in which students gain new knowledge based on what they already know. Using the 5E model in teaching helps students to receive knowledge systematically and effectively. In this article, we analyze the correlation between 5E-model phases and expression of understanding nature competence, and design the lesson plan of "oxygen" Natural Science grade 6 by using the theoretical framework in related references. We also use the expert method in the practical investigation methods to get an idea about the competence structure in understanding nature and designing the teaching plan of the subject Oxygen in Natural Science 6.

**Keywords:** 5E teaching model, Natural Science Grade 6, understanding nature competence.

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# VẬN DỤNG MÔ HÌNH 5E TRONG DẠY HỌC MÔN KHOA HỌC TỰ NHIÊN NHẪM PHÁT TRIỂN NĂNG LỰC TÌM HIỂU TỰ NHIÊN CHO HỌC SINH Ở TRƯỜNG TRUNG HỌC CƠ SỞ

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## Tóm tắt

Theo chương trình môn Khoa học Tự nhiên 2018, năng lực tìm hiểu tự nhiên là một trong ba thành phần của năng lực khoa học tự nhiên, giúp học sinh có khả năng tìm hiểu và giải thích sự vật hiện tượng trong tự nhiên và đời sống bằng các dẫn chứng khoa học. Đặc trưng quan trọng của việc dạy học môn Khoa học Tự nhiên là học sinh cần được trải nghiệm, khám phá những sự vật hiện tượng của thế giới tự nhiên thông qua thí nghiệm, trải nghiệm thực tiễn từ đó hình thành tri thức khoa học và vận dụng tri thức để giải quyết các vấn đề trong cuộc sống. Mô hình 5E là mô hình dạy học khoa học phù hợp với triết lý giáo dục “lấy người học làm trung tâm” và được xây dựng dựa trên lý thuyết dạy học kiến tạo, học sinh xây dựng kiến thức mới dựa trên kiến thức hoặc trải nghiệm đã biết trước đó. Sử dụng mô hình 5E trong dạy học giúp học sinh tiếp nhận kiến thức một cách có hệ thống và hiệu quả. Trong bài viết này, chúng tôi phân tích mối tương quan giữa mô hình 5E và các biểu hiện của năng lực tìm hiểu tự nhiên, vận dụng mô hình này vào thiết kế và tổ chức dạy học bài oxygen ở môn Khoa học Tự nhiên 6. Chúng tôi đã sử dụng các phương pháp phân tích, tổng hợp, hệ thống hóa thuộc nhóm phương pháp nghiên cứu lý thuyết trong tham khảo các nguồn tài liệu có nội dung liên quan đến vấn đề nghiên cứu, sử dụng phương pháp chuyên gia thuộc nhóm phương pháp nghiên cứu thực tiễn để xin ý kiến về cấu trúc năng lực tìm hiểu tự nhiên và kế hoạch dạy học bài oxygen môn Khoa học Tự nhiên 6.

**Từ khóa:** Khoa học Tự nhiên 6, mô hình dạy học 5E, năng lực tìm hiểu tự nhiên.

## 1. Introduction

Resolution No. 29/NQ-TW dated November 4, 2013 of the 8<sup>th</sup> Central Conference, term XI affirms the directive viewpoint of innovative fundamental and comprehensive in education and training “Continue innovation strongly and in sync with fundamental factors of education training oriented to develop the quality and competence of learners” (Central Steering Committee, 2013).

The Overall General Education Program and the General Education Program in Natural Sciences determine necessary qualities and competencies of high school students including the competence to understand nature. Natural science is an important subject for the comprehensive development of students and plays a fundamental role in forming and developing students' scientific worldviews. Therefore, it is necessary to find and apply teaching models in teaching natural science subjects to develop natural science competencies (including the competence to understand nature) for students. Many different teaching methods can develop natural inquiry, including the 5E model. This is a science teaching model based on "student-centered learning" and constructivist teaching theory.

The 5E model developed in the 1980s is widely used in the US and many countries in the world. Wilder et al. (2005) show the using the 5E model to orient the students through the chain of learning activities to discover knowledge. Then, they explain the problem, consolidate, practise, and assess it. Through learning activities, students can accumulate science knowledge better than through the traditional method (Wilder & Shuttleworth, 2005). Ziyafet (2008) investigate the impact of the 5E model on the competence and attitude of students. The results indicate that the students can form higher-order thinking skills by applying the 5E model. Deren (2008) showed that the 5E model and multimedia devices can together increase achievement and attitude in science and technology (Şahin & Baturay, 2016). Fazelian et al. (2010) are aware that the students obtained the knowledge by connecting the knowledge in the lessons at the engagement and exploring phases of the 5E model (Fazelian & Soraghi, 2010). Stephen Akinyemi Omotayo et al. (2017) studied the effect of the 5E model on the learning of students in teaching mathematics. This study showed that the 5E model can improve the results (Omotayo & Adeleke, 2017).

In Vietnam, there have been a number of studies on the use of the 5E model such as Ngo (2019) has built a foundation to apply the 5E model to primary school teaching; Vu (2016) applied the 5E model to design a number of science-themed lesson plans; Le & Nguyen (2020) applied the 6E process to STEM-oriented teaching; Phan (2021) has applied the 5E model in teaching experimental practice with natural science in lower secondary schools to develop the capacity of discovery,... Through the research process, we are aware that using the 5E model in designing the lesson on Natural Science is suitable because the phases of this model contain the expression of competence in learning about nature. In this article, we analyze the characteristics of the 5E teaching model and the manifestations of the competence to learn about nature. Thereby, the specific application to teaching the oxygen lesson in a Natural Science subject in grade 6 responds to the requirements of the new general education program.

## 2. Research content

### 2.1. The 5E teaching model to develop the natural science competencies

The 5E teaching model was proposed by Dr Rodger W. Bybee and his colleagues in 1987 while working for the Biological Sciences Curriculum Study (BSCS) organization in Colorado, USA. After a period of building and testing, the 5E model was known through a report in 2006 with the topic "The BSCS 5E Instructional Model: Origins and Effectiveness".

The model was built based on the constructivist theory of learning, in which learners are active in the process of forming new knowledge through experience and previously known knowledge (Bybee et al., 2006).

This model can give the systematic and comprehensive view for teachers. It is useful in the implementation of diverse contents, teaching science subjects as well as engineering and technology subjects with practical activities and experiments. It can help teachers find the central contents of the lesson and lead the students in learning steps systematically.

This model consists of 5 phases corresponding to 5 letters E: Engage; Explore; Explain; Elaborate; Evaluate.



Figure 1. The 5E model

**Activity 1: Engage**

This is the first and important step in the learning process that stimulate students' interest in learning. This phase allows students to connect and re-connect with the practical experiences and observations that they have had before. In this phase, the teacher attracts students' attention to the lesson and checks their initial understanding. Depending on the lesson's content, a variety of activities can be organized to arouse students' interest.

**Activity 2: Explore**

In this stage, students have the opportunity to directly participate in the learning situations, directly experience activities, work with the equipment, and tools, practice... exploring and discover to build their understanding of the learned topic.

**Activity 3: Explain**

The teacher creates the opportunity for students

to explain experimental results, and phenomena, and find answers to their guesses. Then, the teacher analyzes and makes conclusions. This is also a phase for teachers to explain and standardize terms, concepts, and process explanations.

**Activity 4: Extend**

Teachers create the conditions for students to use newly learned knowledge to continue exploring and solving new problems. Students have the opportunity to practice knowledge and skills in specific situations. As a result, students can deepen their lessons and broaden their knowledge.

**Activity 5: Evaluate**

This phase records results and adjusts for the next lessons. Teachers flexibly use assessment methods and tools to assess students' cognitive processes and abilities. From there, teachers offer appropriate adjustment directions and forms to support students to achieve their learning goals.

**2.2. Competence in learning nature**

Competence in learning nature is demonstrated when students are able to perform some basic skills to understand and explain things and phenomena in nature and life. At the same time, the problems in practice can be proved by scientific data.

Based on the competency framework of learning nature in the Natural Science program in 2018 (Ministry of Education and Training, 2018b), we propose the competence structures in learning nature consisting of 4 component competencies and 8 criteria in Table 1.

Table 1. Component competence and criteria of natural inquiry

The component competence	Criteria
Proposing the problem	Criteria 1. Identify the problem
	Criteria 2. Analyze relationship between relevant knowledge and problem
Giving the hypothesis	Criteria 3. Make judgments, build hypotheses for the problem
Making and executing a relevant plan	Criteria 4. Make a plan to learn the problem (observation, experiment, information collection...).
	Criteria 5. Execute the plan to learn the given problem (observation, recording, description of experimental phenomena, data synthesis, information processing,...).
	Criteria 6. Analyze data and give out the conclusions for research problem.

Reporting the results; Extending the application into practice	<b>Criteria 7.</b> Write a report and present the results of the research problem.
	<b>Criteria 8.</b> Applying the research results to similar or modified situations in practice.

**2.3. Analyzing relationship between the 5E phases and competence criteria in Natural Science learning**

From the above comparisons, we are aware that the teaching process based on the 5E model with the

specific requirements of each phase is similar to the competence in learning Natural Science. Therefore, applying the 5E model will have many opportunities to contribute to the development of the competence in learning Natural Science.

**Table 2. The 5E phases - competence criteria relationship in Natural Science learning**

Phases	Criteria
<p><b>Activity 1: Engage</b> The teacher creates a problem situation with an experiment or a video... Students observe and ask questions. Record what happens. The teacher helps the students in connections with previous knowledge or experiences.</p>	<p><b>Criteria 1.</b> Identify the learning problem</p>
<p><b>Activity 2: Explore</b> Students will directly experience activities to discover new knowledge. The teacher is the person who provides the background knowledge of the learning medium so that the students can perform their tasks. Practical experiences include various forms such as observation and prediction, experimentation, design, data collection,...</p>	<p><b>Criteria 2.</b> Analyze the relationship between relevant knowledge and the problem of learning about <b>Criteria 3.</b> Formulate hypotheses for the problem to be studied. <b>Criteria 4.</b> Make a plan to learn the problem (experiment, observation, information collection,...). <b>Criteria 5.</b> Implement the plan to learn the problem set-up (observe, record, describe experimental phenomena, synthesize data,...).</p>
<p><b>Activity 3: Explain</b> From the experiences in the explore phase, students will present an analysis describing what they have learned through the experience. The teacher guides the students to synthesize the knowledge they have received. Answer their questions and then conclude with new knowledge.</p>	<p><b>Criteria 6.</b> Analyze data and give the conclusions for research problem.</p>
<p><b>Activity 4: Elaborate</b> Improve skills and understand by applying knowledge to new challenges and solving different situations. Students can understand new concepts more deeply. Consolidate knowledge before being assessed through tests.</p>	<p><b>Criteria 7.</b> Write a report and present the results of the research problem. <b>Criteria 8.</b> Apply research results to similar or modified situations in practice.</p>
<p><b>Activity 5: Evaluate</b> Evaluate as a test or as a practice exercise quiz; write and present discussion reports... Teachers adjust and provide appropriate support to help students achieve the set learning goals.</p>	

**2.4. Applying the 5E model in teaching the content “Oxygen” in Natural Science subject grade 6**

Objectives: By the end of the lesson, students are able to:

- Present some properties of oxygen.
- Explain the importance of oxygen for life, combustion and fuel combustion.

The process of teaching "oxygen" content in the sequence of 5 phases of the 5E model is illustrated:

**Activity 1. Engage (five minutes)**

Teacher's activities	Students' activities	Products
<ul style="list-style-type: none"> <li>- Teacher organizes the game "Who am I".</li> <li>+ Set the rules of the game and guide students to play game.</li> <li>+ Gradually introduce information with pictures to help students to answer "Who am I".</li> <li>- Teacher provides answers and leads to Oxygen: Oxygen is also known as oxygen because it maintains the respiratory process for all living things. Without oxygen, we cannot burn fuels. So, what is the basic property of oxygen and how is it important to life?</li> </ul>	<ul style="list-style-type: none"> <li>- Students receive their task and participate in the game. Observe the picture in the data and answer the keyword "Who am I".</li> <li>+ Data 1: Every living thing needs me.</li> <li>+ Data 2: I am everywhere in the land, in the water, in the air.</li> <li>+ Data 3: I am a part of the air.</li> <li>+ Data 4: Patients with dyspnea cannot do without me.</li> </ul>	<ul style="list-style-type: none"> <li>- Students' answers to the keyword "Who am I".</li> <li>- Students identify the problem that needs to be learned is the properties and the importance of oxygen for life, combustion and fuel combustion.</li> </ul>

**Activity 2: Explore (fifteen minutes)**

Teacher's activities	Student's activities	Products
<ul style="list-style-type: none"> <li>- The teacher lets the students work independently to complete questions from 1 to 4 in worksheet number 1, from which a comment can be drawn on some properties of oxygen.</li> <li>- The teacher lets the students work in pairs to complete questions from 5-7 in learning card number 1, thereby drawing the role of oxygen in life.</li> <li>- Teacher comments and supplements for students.</li> <li>- Teacher divides the class into groups.</li> <li>- The teacher provides experimental equipment, and asks students to propose an experimental plan on the ability to maintain the combustion of oxygen.</li> <li>- Teachers suggest guidance if students have difficulty performing learning tasks.</li> <li>- Teachers ask the group of students to complete questions 8-9 in learning card number 1, thereby drawing the role of oxygen in combustion.</li> <li>- Teacher comments and supplements for students.</li> </ul>	<ul style="list-style-type: none"> <li>- From the knowledge learned, combined with practical knowledge, students work independently to complete questions 1-4 in worksheet number 1, concluding about the properties of oxygen.</li> <li>- From the knowledge they have learned, combined with practical knowledge, students work in pairs using the "think-pair-share" technique to answer questions 5-7 in worksheet number 1 and draw conclusions about the roles of oxygen in life.</li> <li>- Students discuss in groups to propose plans, how to conduct experiments, and record experimental results.</li> <li>- Use a lighter to light 2 sticks, lightly flicking until only red ash remains. Take 2 fireflies with red remnants, 1 stick in the oxygen tank, 1 stick in the air.</li> <li>- Students observe the phenomenon and draw comments.</li> <li>- Complete the worksheet, and draw conclusions about the properties and importance of oxygen for life and combustion.</li> </ul>	<p>The answers of students and groups of students in the worksheets.</p>

**LEARNING SHEET NO.1**

<p><b>Question 1:</b> Where do you know Oxygen exists?</p> <p><b>Question 2:</b> Every day, we breathe oxygen in the air. From there, state your feelings about the color, smell and taste of Oxygen.</p> <p><b>Question 3:</b> Home aquariums often add algae and need to add an Oxygen generator for what? Is oxygen more or less soluble in water?</p> <p><b>Question 4:</b> Why do you feel breathless the higher you go, this proves that oxygen is heavier or lighter than air?</p>
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**Question 5:** Would life take place if the Earth did not have Oxygen? Can you describe the role of oxygen in the life of living things?

**Question 6:** Please find out and tell which patients must use oxygen cylinders to breathe.

**Question 7:** A compressed air tank is a container that stores air that is compressed at a certain pressure. Why do divers need to use compressed air tanks?



**Figure 2. The red dot has just gone out in the air**



**Figure 3. Red embers ignite after being put into the Oxygen tank**

**Question 8:** Observing Figures 1 and 2, what role does Oxygen play in combustion?

**Question 9:** Why do we often fan (blow) strongly into the kitchen if we want the fire to burn bigger?

**Activity 3: Explain (ten minutes)**

Teacher's activities	Student's activities	Product
- Asking groups of students to present their findings and explain.	- The groups present the results they have learned about the properties and importance of oxygen for life and combustion.	- Oxygen is a colorless, odorless gas, heavier than air, slightly soluble in water.
- Projecting answers and explanations, leading and suggesting for students to draw out about the properties and importance of oxygen for life and fire from practical knowledge and experiences of students.	- Drawing conclusions about the properties and role of oxygen in life and combustion.	- Oxygen helps sustain life, and fire.

**RESULTS OF LEARNING CARD NO.1**

**Question 1:** Oxygen exists in the atmosphere.

**Question 2:** Oxygen is colorless, odorless, tasteless.

**Question 3:** Algae, photosynthetic algae produce oxygen, attach an oxygen aerator to provide oxygen for fish Respiratory. Oxygen is sparingly soluble in water.

**Question 4:** The higher you go, the more difficult it is to breathe due to the lack of oxygen, which proves that oxygen is heavier than air.

**Question 5:** Without oxygen there would be no life on earth. Oxygen is important for the life of organisms because all living things need oxygen to maintain all cellular activities.

**Question 6:** The oxygen in the gas cylinder will have the effect of supporting patients with common symptoms such as respiratory failure, suffocation, heart disease, breathing disorders. In addition, in medicine, doctors will give patients oxygen when carbon monoxide poisoning, especially when needing to anaesthetize the patient to perform surgery.

**Question 7:** Compressed air tanks provide oxygen for divers to breathe in an airless environment.

**Question 8:** The red embers burn in the oxygen tank and turn off when left in the air, showing that oxygen plays a role in maintaining the fire.

**Question 9:** When blowing or strong fan on the stove will increase the amount of oxygen provided for the combustion process. Helps the fire to take place stronger, more heat is released.

**Activity 4: Elaborate (eight minutes)**

Teacher's activities	Students' activities	Products
<ul style="list-style-type: none"> <li>- Teachers let students observe pictures of fires and ask questions: What elements do you need to have a fire? From there, how to put out the fire? Should water be used to extinguish gasoline fires? Please suggest measures to extinguish the group caused by gasoline.</li> <li>- The teacher let the groups present the answer plan, explain, and other groups supplement.</li> <li>- The teacher commented on the answers of the groups, the teacher introduced and explained some more ways to extinguish the petrol fire such as using wet blankets, sand,...</li> </ul>	<ul style="list-style-type: none"> <li>- From the knowledge learned above combined with the knowledge Practical knowledge Students can answer the question of conditions for a fire and state measures to extinguish the fire.</li> <li>- Students discuss to explain and propose a plan to extinguish the fire caused by gasoline.</li> </ul>	<ul style="list-style-type: none"> <li>- Students can answer the question of conditions for combustion: The combustible substance must be hot to the burning temperature; Must be exposed and have enough oxygen for combustion.</li> <li>- The measure to extinguish the fire is to lower the temperature of the combustible substance below the combustion temperature; Isolate the combustible from oxygen.</li> <li>- Do not use water to extinguish a gasoline fire because it will make the fire spread more.</li> <li>- To put out small petrol fires, people can use wet blankets, sand,...</li> </ul>

**Activity 5: Evaluate (seven minutes)**

Teacher's activities	Students' activities	Products
<ul style="list-style-type: none"> <li>- Let students do fish exercises multiply according to worksheet number 2.</li> <li>- Call on some students to present their answers, other students comment.</li> <li>- Teachers comment, explain, draw conclusions.</li> </ul>	<ul style="list-style-type: none"> <li>- Students solve exercises.</li> <li>- Comment your answers.</li> </ul>	Students' answers.

**LEARNING SHEET NO.2**

<p><b>Question 1:</b> What actual phenomenon shows that oxygen is sparingly soluble in water?</p> <p><b>Question 2:</b> Medical oxygen is an essential drug in the treatment of Covid-19. So, what is medical oxygen like? How does it help patients during treatment?"</p> <p><b>Question 3:</b> What fuel source does your family use for cooking every day? Does that fuel need to use oxygen to burn?</p> <p><b>Question 4:</b> Some households use wood stoves for daily cooking. When the fire is about to end, people add wood and blow or fan the stove, and the fire burns up. Let me explain how to do that.</p> <p><b>Question 5:</b> What elements do you need to have a fire? From there, how to put out the fire?</p>
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**RESULTS OF LEARNING SHEET NO.2**

<p><b>Question 1:</b> Actual phenomena show that oxygen is less soluble in water: fishes in ponds and lakes sometimes come to the surface to catch a ball; People often install oxygen blowers in aquariums or oxygen aerators in lakes, ponds, shrimp and fish,...</p> <p><b>Question 2:</b> Medical oxygen is a form of oxygen with high purity (99.5% or more). up) is applied in activities related to human health, has the effect of helping people breathe and survive. When infected with covid 19, the virus will attack the lungs leading to respiratory failure, the patient cannot perform the oxygen exchange process by himself but needs the help of a ventilator.</p> <p><b>Question 3:</b> Honeycomb charcoal, firewood, gas, ... these fuels need to provide oxygen (air) to burn. If using an electric or induction cooker, there is no need to provide oxygen.</p> <p><b>Question 4:</b> Adding firewood means adding fuel, blowing or fanning increases the oxygen content to maintain combustion.</p> <p><b>Question 5:</b> Conditions for combustion: The combustible substance must be hot to the burning temperature; The combustible must be exposed to oxygen and have enough oxygen for combustion.</p> <ul style="list-style-type: none"> <li>- The measure to extinguish the fire is to lower the temperature of the combustible substance below the combustion temperature; isolating the combustible from oxygen.</li> </ul>
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### 3. Conclusions

The application of the 5E model in teaching Natural Science in grade 6 has contributed to educational innovation towards developing nature-understanding competences for learners. Teaching activities designed according to the 5E model will contribute to the formation and development of specific criteria of natural inquiry competence. The lesson plan is built according to the phase sequence of the 5E model, making the teacher's teaching more logical and systematic. From there, students can explore, absorb knowledge, and develop their ability to learn about the nature effectively.

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