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APPLICATION OF THE MODEL 5E TO DESIGN A TEACHING PLAN FOR THE TOPIC "WHAT ARE THE CHARACTERISTICS OF WATER?" IN 4TH GRADE SCIENCE SUBJECT OF VIETNAM IN STEM EDUCATIONAL ORIENTATION

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Abstract:
STEM education is an educational model based on the interdisciplinary integration of science, technology, engineering and mathematics to solve real-life problems (Bentley et al., 2022; Kaleci & Korkmaz, 2018). When implementing STEM education in primary schools, there are many different approaches: discovery model, engineering design model, 5E, 6E, TRIAL model (Chacko et al., 2015; Kaleci & Korkmaz, 2018; Matsuura & Nakamura, 2021; Stohlmann et al., 2012). The selection of a model to apply appropriately is important, depending on the student, the actual teaching conditions, the teaching content, etc. The article analyzes the content of Science in primary school, teaching practice in Vietnam and illustrates the design of a specific teaching plan for grade 4 students on the basis of applying the model 5E to organize STEM education-oriented teaching in order to provide teachers with an approach when designing science teaching plans for primary school students.

Keywords: STEM, STEM education, teaching plan, the model 5E, primary school students, science subject

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1. Introduction

In the context of the 4.0 revolution, the world has been having impacts and changes in all fields of economy, politics, culture, education and society. For education, educational goals in the 21st century have many changes (Bircan & Çalışıcı, 2022; Homa, 2019). Learners in the 21st century not only need scientific knowledge and skills associated with subjects, but more importantly, they need to be equipped with interdisciplinary knowledge and skills to be able to deal with and solve complex problems associated with the world context (Yakman G. et al., 2012; Bircan & Çalışıcı, 2022). Many researchers have pointed out many modern teaching trends, such as differentiated teaching, integrated teaching, teaching by doing. In particular, the trend of integrated teaching and STEM education is emphasized as a trend with many advantages that can be met with education to develop the capacity of primary school students in Vietnam (Thi et al., n.d.; Thu Hang & Tu Quyen, 2022). When studying STEM education, many researchers have pointed out the outstanding advantages of this educational method, such as helping learners develop problem-solving capacity, increasing learners' creativity (Morrison, 2006), promoting learners' thinking through art discovery manipulations (Cho, 2013 (1)), contributing to student innovation (Daugherty, M. K., 2013), developing interdisciplinary thinking (Tenaglia, T., 2017) and stimulating learners to be more interested in the application of science, technology, engineering, and math elements to solving problems of daily life (Sochacka, N. W., Guyotte, K. W., & Walther, J., 2016).

In Vietnam, after the 2018 General Education Program was promulgated, many modern teaching trends and models were implemented, aiming at teaching to develop the quality and capacity of students (Ministry of Education and Training, 2018a; Thi et al., n.d.). The term STEM introduced and described in the National General Education Program of Vietnam is emphasized as an effective approach, implemented from the primary school level (Ministry of Education and Training, 2018a). However, the comprehensive renovation of general education in Vietnam is in the early stages of implementation, many primary school teachers are still confused with STEM education, and the ability to design and organize STEM education topics still faces many difficulties due to the lack of implementation of specific guidelines (Thi et al., n.d.; Thuy et al., 2022). Therefore, it is necessary to study the implementation models of STEM education through a number of primary school subjects to develop specific teaching plans.

2. Research questions

The purpose of the article is to analyze the model 5E and its application process in teaching Science to 4th grade students according to the STEM education method to answer the questions: What is STEM education and the model 5E? ? How is it characterized? Why is the model 5E suitable for teaching Science subject to STEM education? Then apply the model 5E to design an illustration of a lesson plan on the topic "What are the characteristics of water?" in STEM education.

2. Research content

2.1. STEM education

STEM is an acronym for Science, Technology, Engineering and Mathematics. Science is considered as a field that develops the ability to explore, and learn about scientific knowledge, the natural world and society around and apply that knowledge to solve problems in daily life. In Vietnam's primary school curriculum, Science is formed and developed mainly through Nature and Society (grades 1, 2, 3) and Science (grades 4, 5) (Ministry of Education and Training, 2018b; Ministry of Education and Training, 2018). The technology aims to develop students' ability to use, manage, understand and evaluate the technology. It provides students with opportunities to learn about the evolution of technology and provides students with the skills to analyze the impact of new technology on their daily lives and the community. Engineering aims to develop students' understanding of how technology is evolving through the engineering design process. Technology provides students with opportunities to integrate the knowledge of multiple disciplines, making related concepts more visible in students' lives. Engineering also provides students with the skills to creatively apply the foundations of Science and Mathematics in the design of objects, systems, or the construction of manufacturing processes. Mathematics is a subject that aims to develop in students the ability to analyze, reason and communicate ideas effectively through calculating, explaining and constructing and proposing solutions to solve mathematical problems in specific situations (Bentley et al., 2022; Chacko et al., 2015; Kaleci & Korkmaz, 2018; Matsuura & Nakamura, 2021).

STEM education is also defined based on different interpretations. It is an interdisciplinary approach to learning where academic knowledge is closely combined with real-world lessons through the application of Science, Technology, Engineering and Mathematics into concrete contexts (Aguilera & Ortiz-Revilla, 2021; María, Soledad Ramírez, 2017; Pratama et al., 2022; Stohlmann et al., 2012). In the General Education Program of Vietnam, STEM education is understood in the following sense: "*STEM education is an educational model based on an interdisciplinary approach that helps students apply knowledge of science, technology, engineering and mathematics in solving some practical problems in specific contexts*" (Ministry of Education and Training, 2018a). In Vietnam's primary schools, STEM is being implemented in two basic ways: (1) STEM education through teaching subjects in the STEM field; (2) STEM education through experiential activities associated with educational activities. When approaching implementation in a first way, Science is a subject with great potential, and the subject's STEM topics can be taught only in Science, or can also be taught in many different parallel studies, especially in Mathematics and Technology (Ministry of Education and Training, 2018a). STEM topics are taught in Science, which combines Mathematics and Technology, requiring a very close connection of knowledge between subjects. The subjects still approach the topic from the perspective of their own professional knowledge. But the content solved in the previous subject will be the next premise to teach in the next subject. Subjects must be

coordinated with each other to teach overlapping thematic content (Ministry of Education and Training, 2018).

2.2. The model 5E following STEM education

In 1987, the model 5E was developed by Rodger W. Bybee and his colleagues in the Biological Sciences Curriculum Study (BSCS) in the US. This is a model based on constructivism theory, in which students mobilize their own knowledge and experiences to experience, form ideas and build new knowledge (Bybee R.W., 2014). The model 5E of the research group Bybee is inherited and developed from the learning cycle of Myron Atkin and Robert Karplus (Atkin, J. M., & Karplus, R., 1962). The model 5E is based on the constructivist theory of learning. Accordingly, learners build knowledge from the process of experience. The model 5E includes 5 stages in a chain of the teaching process: Engagement, Exploration, Explanation, Elaboration and Evaluation (Çiğdem Şahin et al., 2017).

The 5 stages in the learning process according to the model 5E in the direction of STEM education can be described as follows:

Figure 2.1: Model 5E

A. Engagement

This is the start of a learning process based on model 5E. In this step, the teacher presents a situation, a question or a problem to arouse curiosity in students who connect and mobilize the knowledge and learning experiences they have had to solve the problem (Thi et al., n.d.). In teaching Science in the direction of STEM education, this is the stage when teachers give situations and questions with scientific problems to stimulate interest and stimulate students to participate in exploration and discovery. These are often conflicting learning situations that need to be resolved, prompting the question "Why?" for students, for example: When studying *what plants need to live*, the teacher asked the

question: *Why do plants need adequate water to live and grow, but cacti can live well on the desert?*

B. Exploration

At this stage, students are engaged in interactive and experiential learning activities to build background knowledge for STEM lessons/topics. It is the new knowledge of the lesson, discovered by students on prepared materials or utensils, propose measures, create ideas and investigative plans, and collect information to solve problems. The problem has been raised in the previous step through activities of observation, description, recording, experiment, design, data collection mainly with a group of students and teachers' advice and support.

C. Explanation

At this stage, through students synthesizing and drawing new knowledge from the previous stage, teachers encourage students to explain concepts, definitions and newly learned contents by sharing and explaining the way of doing things, presenting examples and arguments, comparing them with the explanations given by other friends or groups, describing and analyzing the experiences or observations obtained in the Exploration stage. From there, students mobilize their knowledge and skills to practice investigating, discovering and proving proposed ideas related to STEM education topics. In this stage, teachers can direct learners to deepen their understanding of the STEM topics under study based on in-depth questions at the level of comparison, analysis, generalization, and evaluation.

D. Elaboration

At this stage, teachers create opportunities for students to apply concepts and skills learned in the previous stage to solve new situations with high practicality and application. Students practice and share the results by presenting, reporting, and describing the process of implementing ideas. This is the stage when students' scientific knowledge is confirmed, and the process of applying learned knowledge into practice is initially implemented by students through creating STEM products from newly learned knowledge.

E. Evaluation

This is the final stage in the model 5E. At this stage, students are encouraged to self-assess to review the process of participating in activities and draw scientific knowledge on STEM topics. Students can consider, think about their learning, change necessary knowledge, skills and attitudes. Teachers create opportunities for students to self-assess, cross-evaluate between groups, and at the same time make comments and assessments through group observation, learning products, and individual and group activities to provide an overview of the student's progress.

2.3. Applying the model 5E to design a lesson plan on the topic "What are the characteristics of water?" in 4th grade Science subject toward STEM education

2.3.1. 4th grade Science subject and the application of the model 5E towards STEM education

Vietnam's new general education program emphasizes the formation and development of qualities and competencies for students (Ministry of Education and Training, 2018a). Science subject in primary school aims to form and develop for students' ability to perceive natural science, to learn and discover nature through observation and experiment, to apply synthetically scientific knowledge to solve problems in life (Ministry of Education and Training, 2018). Therefore, in teaching 4th and 5th grade Science subject, the application of the model 5E and STEM education has many advantages and advantages to promote the active learning of students, towards the goal of comprehensive development: (1) Creating an environment for students to explore, discover and create science through STEM skills; (2) Practicing practical problem-solving skills and scientific inquiry capacity; (3) Making connections between scientific knowledge and skills with specialized fields in STEM.

The structure of the Science lesson plan/topics designed according to the model 5E in the direction of STEM education is outlined as follows:

Name of the lesson

1. Goals

- Knowledge and skills in STEM lessons/topics.
- Qualities and abilities are contributed to the formation and development.

2. Teaching aids

- Teacher
- Student

3. Teaching activities

Teaching process	Teaching activities
Engagement	
Exploration	
Explanation	
Elaboration	
Evaluation	

2.3.2. Lesson plan on the topic "What are the characteristics of water?" in 4th grade Science subject

A. Goals

After the lesson, students can:

- State some characteristics of water (colorless, odorless, tasteless, shapeless; flowing from high to low, spreading in all directions; permeating some objects and dissolving some substances).
- Apply the characteristics of water in some simple cases.

* *Knowledge and skills in STEM topics:*

- Science (S): State the characteristics of water;
- Technology (T) and engineering (E): Using simple materials to experiment and create raincoat products from plastic bags.
- Mathematics (M): Compare and measure the sizes of utensils and materials to make products.

** Students have the opportunity to form and develop responsible and hardworking qualities; communication and cooperation capacity; problem solving and creativity.*

B. Teaching aids

- Teacher: 3 identical bottles (1 bottle of milk, 1 bottle of clean water, 1 bottle of cooking oil), cover the surroundings with colored paper, projector, worksheets.
- Students: glass cup; filtered water, milk, cooking oil, salt, sugar, sand; a small cloth (cotton, blotting paper, ...); spoons, plates, bottles, jars, vases, cups of different shapes, glass panels (thin wood panels...), trays.

C. Teaching activities

Teaching process	**Teaching activities**
Engagement	- Teacher divides students into groups (4-6 students/1 group) - The teacher places 3 identical bottles: 1 bottle of milk, 1 bottle of clean water, 1 bottle of cooking oil that was covered around with colored paper, leaving only the bottle cap open and asked the question: "Look at 3 bottles of this liquid without tearing the colored paper and find out which is the clean water bottle? Please explain your group's choice?" - Students make their initial predictions about clean water bottles from their existing knowledge. - The teacher led the lesson "What are the characteristics of water?"
Exploration	- Organize for students to work in groups of 6, ask students to discuss the following and record the discussion results on the worksheet: a) Learn about the color, smell, taste of water + How to recognize the color, smell and taste of water? + What do you need to use to learn about the color, smell, taste of water? b) Learn about the shape, flow of water, permeability and solubility of water. + How to recognize the shape of water, the way it flows, the permeability and solubility of water with substances? + What tools do you need to use in each experiment? c) Agree in the group of options to choose to perform the experiments. - The teacher organizes for students to present their group's experimental plan and the corresponding equipment to be prepared. Explain your group's choice. - The groups compare, comment and agree on how to conduct their own experiments. - The teacher emphasizes that students should pay attention to safety during the experiment. d) Students perform the experiment, record the observation results - The teacher organizes for students to perform the experiment in groups using their proposed group plan, observe and record the results of the experiment and the knowledge about the characteristics of water drawn from the experiment.

Explanation	- Organize for groups to draw 1 content to report to the class: + Experiment to learn about the color, smell and taste of water. + Experiment with the shape of water. + Experiment with water flow. + Experiment to demonstrate the penetration of water and the solubility of water for some substances. - Groups comment evaluate and discuss: *What are the characteristics of water?*
Elaboration	- The teacher organizes for students to create raincoat costumes from used materials. - Students complete the raincoat product. The teacher gives the following criteria: + Raincoat can be used. + Product presentation on the basis of applied analysis of water properties.
Evaluation	- Group product demonstration and exchange*: How have we used the characteristics of water in our daily lives? Tell some more applications about the characteristics of water in life?* - The teacher checks the application of knowledge about the characteristics of water through student presentations about the product. - The teacher compares the products of the groups that have met the requirements, praise the groups that have completed the tasks well. - The teacher reminds students about making other applied products from the characteristics of water.

3. Conclusion

The model 5E can be applied to organize Science teaching in the direction of STEM education. The organization of teaching according to this model usually takes longer time than the traditional teaching method, so each lesson/topic for teaching Science usually lasts from 2 to 3 periods. The organization of teaching should have a combination of teaching in the classroom and teaching outside the classroom, aiming to not only create opportunities for students to be active, explore and discover new knowledge and skills, but also help students learn new skills. Students have the opportunity to practice and apply the knowledge and skills of the lesson to solve practical problems and create highly applicable products and models. The model 5E of approaching STEM education has more advantages when it comes to creating learning activities for students to learn new lessons on their own; thereby contributing to the practice of teamwork skills, critical thinking and creative problem-solving for students.

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Conflict of Interest Statement
The authors declare no conflicts of interest.

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