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Applying STEM and the 5E Model to Teaching: "Making Soap from Coconut Oil in Vietnam"

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Abstract
Soap is an indispensable product in households, schools, offices, and hospitals in the prevention of diseases such as Covid-19 and respiratory diseases. Vietnam is a country with plentiful coconuts, and the mass production of soap products from coconut oil is feasible and highly competitive. Therefore, science, technology, engineering, and mathematics (STEM) teaching on the topic of making soap from coconut oil is practically meaningful. As a result, not only are students educated on the importance of soap but also develop their STEM knowledge. They also become engaged in their learning and try hard to perfect their products in the fastest and best way possible. Among the teaching methods of making soap from coconut oil, the 5E (engagement, exploration, explanation, elaboration, and evaluation) cycle model is the most appropriate. This teaching model helps students thoroughly explore the knowledge and to work harmoniously in groups. The study aimed to investigate how 9th Grade students at Vo Van Tan Secondary School, Ho Chi Minh City made soap from coconut oil. These students were members of 9A2 and 9A7. After learning how to make soap from coconut oil, students can make similar products, such as dishwashing detergent, from fruit or vegetable peels. This model thus helps students to be creative in STEM disciplines through problem analysis and exploration. We found that the students

were very interested in making natural products such as soap and, in addition to STEM and 5E learning, they addressed an important real-world challenge with their own safe and simple handmade soap for hand-washing, disinfecting, and pandemic prevention.

Keywords: 5E cycle, coconut oil, prevention of pandemics, soap, STEM.

1. Introduction

Making soap is a crucial real-world challenge presenting many opportunities for science, technology, engineering, and mathematics (STEM) and 5E learning. Up to now, the Covid-19 pandemic has had many serious impacts on the lives of people around the world. Diseases such as monkeypox and hand, foot, and mouth disease are spreading rapidly. To prevent Covid-19 as well as other diseases from spreading through the respiratory tract, UNICEF has recommended that everyone, including students at school, should wash their hands regularly with soap. Students should develop a habit of washing their hands before snacks, lunches, and going home. Schools should display handwashing posters at entrances and provide enough soap and alcohol-based hand sanitizer. In addition, schools must schedule daily cleaning of school facilities, including toilets, with water, detergent, soap, and disinfectant, as well as regularly disinfect frequently touched surfaces and objects such as doorknobs, desks, toys, objects, light switches, door frames, teaching aids, book covers, etc. (WHO, 2020).

Since soap is essential to life, its mass production is of great concern. It is important to teach students how to make natural soap from coconut oil, an environmentally friendly product. To teach students how to make soap from coconut oil, the 5E cycle model (engagement, exploration, explanation, elaboration, and evaluation) is the most appropriate model. The 5E model is based on the constructivist learning theory (Nguyen, 2018). In 1987, Dr Rodger Bybee and his associates working at the Biological Sciences Curriculum, a Colorado-based (USA) educational organization, proposed an improved teaching model for biology in elementary schools. The theory suggests that individuals build new knowledge based on their current knowledge through their own interaction in teaching activities (Akar, 2005). The effectiveness of the 5E model has been recognized. In the United States, the 5E model is quite popular in science curricula, including both formal and extracurricular.

In STEM educational programs, the 5E model becomes an effective tool that helps students feel that they take the lessons systematically and seamlessly and have the opportunity to develop self-discovery and constructivism. Many recent studies have shown that the 5E model has plentiful positive effects in teaching, the major of which being that students find it easier to remember knowledge and lessons. For teachers, the 5E model makes lesson preparation simpler and more systematic and helps create diverse activities for students to experience. This teaching process helps teachers reduce the amount of time spent on teaching theories, and instead creates practical discovery activities, which promote a student-centered philosophy. The role of the teacher is to create an experiential learning environment that helps students step by step to discover new knowledge based on previous knowledge. Interestingly, it is

shown that the teachers who teach STEM subjects, after applying the 5E method, are more excited and find it easier to teach lesson content. They can avoid the risk of omitting important knowledge or experiential activities (Nguyen, 2018).

The study aimed to answer the following questions:

1. What are the characteristics of teaching according to the 5E model?
2. What are factors to consider when applying the 5E cycle model for STEM teaching?
3. How do the five steps of the 5E model apply in teaching the lesson "Making soap from coconut oil at Vo Van Tan Secondary School, Ho Chi Minh City in Vietnam"?

2. Literature review

2.1. Characteristics of teaching according to the 5E model

The 5E teaching model consists of five phases, as described in Table 1.

Table 1: The 5E teaching model

Phase	Teacher activities	Student activities
Engagement	– Ask questions, do exercises or simple practice that stimulate students, and make connections between past and present learning knowledge. – Encourage students to ask questions to solve their own problems.	– Answer questions, do the practice. – Find connections between past and present learning knowledge. – Ask questions about upcoming problems.
Exploration	– Provide supporting materials and organize discovery activities for students to explore. – Observe and listen to students' interactions.	– Study supporting documents, do discovery activities. – Report discovery results and discuss.
Explanation	– Organize discussion to explain the findings (and evidence given) in the exploration phase. – Explain concepts or terms encountered during the exploration phase.	– Discuss to give evidence and explain the discoveries in the exploration phase. – Systematize scientific knowledge in general form (tables, diagrams, ...).
Elaboration	– Encourage students to apply or expand concepts and skills in new situations. – Create relevant situations attached to life for students to solve and then apply in practice.	– Connect concepts between old and new experiences. Apply learned concepts and skills to explain similar situations. – Use learned knowledge to ask questions, and propose solutions to draw conclusions.
Evaluation	– Observe the learning process of students. Provide feedback and adjustments.	– Self-evaluate own progress by comparing current and previous understanding.

	– Provide summative feedback based on students' self-assessment to determine how much learning and understanding were obtained compared to the target.	– Ask new questions to explore more deeply into a learned concept or topic.

(Colclasure et al., 2020; Ninh, 2020; Özenç et al., 2020; Schallert et al., 2022)

2.2. Factors to consider when applying the 5E cycle model in STEM teaching

Although the 5E cycle model has many positive effects in teaching science subjects and integrated STEM education, there are factors to consider when applying and implementing it. According to Dr Rodger Bybee (Bybee et al., 2006), the father of this model, to optimize the use of the 5E cycle model, each module (also known as cycle) should be structured over two to three weeks, and each cycle phase in a module should last from one to three sessions. Note that modules are different from lesson units. For example, the module of study of energy may include many different lesson units: kinetic energy, potential energy, thermal energy, etc. A module of five cycle phases applied in such period of time will enable students to have extra time to take more steps, such as exploration and elaboration. Conversely, if the 5E cycle model is applied in only one lesson unit or one session, it will limit students' exploration activities and put a lot of pressure on the teacher while administering the class. Likewise, if the 5E cycle model is applied to the whole curriculum (e.g., 15 weeks), it will reduce students' interest and focus at each phase (Nguyen, 2018).

Educators have also suggested that no phase of the 5E model should be skipped or any order be changed. Research has shown that if this is done, learners' cognition and performance are influenced to a certain extent. Many teachers tend to skip the engagement phase and go straight to the explanation phase instead, which causes students to feel disconnected from previously learned knowledge. In addition, researchers have recommended that teachers should be flexible in the evaluation phase and combine formative evaluation with integrated assessment when applying the 5E model. Assessment is not necessarily carried out at the end of the model, but can be performed concurrently within phases. If students can receive highly regular feedback, they can correct their mistakes timeously and perfect their study performance (Nguyen, 2018).

The 5E model is believed to be most effective when students encounter new concepts for the first time, because it is the opportunity for a complete learning cycle. According to the inventor of the 5E model, Bybee, the model is best used in a period of two to three weeks, with each cycle phase consisting of one or more lesson units (Bybee et al., 2006). Bybee explained: "*Using the 5E cycle model in only one single lesson decreases the effectiveness of cycle phases due to time shortening and lack of opportunities for learning challenging*" (Bybee et al., 2006). On the contrary, if the teacher spends too much time on each phase, the 5E cycle model is no longer effective, as students may forget the learned knowledge (Nguyen, 2018).

We collected data by surveying students from Vo Van Tan Middle School, Ho Chi Minh City, Vietnam. Survey data were used in addition to information provided by

the students in grades 9A2 and 9A7 and the context of the students' production of coconut oil in the school laboratory. Students had to answer questions related to the coconut oil production process so that teachers could assess their understanding of the lesson.

3. Results

The five steps of the 5E model were followed in teaching the lesson "Making soap from coconut oil in Vietnam". The steps are discussed in this section.

3.1 Engagement

At this step, the teacher creates excitement and promotes curiosity about the STEM topic they need to teach by raising questions and clarifying answers or findings that students have already known (Nguyen, 2018). Students are introduced to new concepts and know how to connect past and present knowledge. They enjoy participating in the learning experience the teacher offers (Bybee et al., 2006).

a) Setting the problem

The Vietnamese Government has set many strong measures in place to prevent Covid-19 as well as other respiratory diseases. One of the most important and useful recommendations is that people regularly wash their hands with soap (Vietnam. Ministry of Health, 2022). Therefore, soap production is currently of great concern. Among soap products, natural soap is given much attention thanks to its harmlessness to the environment. Vietnam is a country with plentiful coconuts, which can considerably lower the cost of coconut-based soap production.

b) Determining the subjects, duration, and implementation form

The subjects are students in Grade 9; the implementation time is 45 minutes; and the topic lesson takes place in school laboratories and classrooms.

c) STEM knowledge in the topic lesson (Table 2).

Table 2: STEM knowledge in the topic lesson

STEM discipline	Applied knowledge
SCIENCE (S)	How to identify the soap environment and measure the pH of the solution.
TECHNOLOGY (T)	Extracting fat from coconut. Using ingredients that are easy to find and safe for food hygiene.
ENGINEERING (E)	Separation process of coconut oil. Process of making soap from coconut oil.
MATHEMATICS (M)	Calculating the pH of the solution.

d) Objectives of the topic lesson

In terms of knowledge, students can understand the principles of making coconut oil from easy-to-find ingredients, make soap from different ingredients, and understand the role of fat and its practical applications in everyday life.

In terms of skills, manipulation of lab equipment and chemicals helps students know how to measure pH in soap environments, form teamwork skills, analyze phenomena in life scientifically, and apply knowledge from learned topic lessons, such as fat, fat synthesis from plants, etc., in real life.

In terms of attitude, when students understand the role of soap and how to make soap from real-life ingredients, they are more interested in learning and exploring practical science, which generates strong motivation to develop and create new things. Students improve self-discipline by strictly adhering to the safety regulations in the soap-making process as well as actively participating in learning activities.

3.2 Exploration

In this step, the teacher asks students general questions to find answers. The teacher encourages students to work together without direct guidance from the teacher. The teacher observes and listens to students during the interaction. Note that the teacher can ask questions to test students when needed. In addition, the teacher should provide enough time for students to solve problems. The teacher acts as a consultant for the students and creates a "must-know" list that students use as basis to improve their STEM products (Nguyen, 2018). Students need to listen to suggestions, observe, explore, collect data, make STEM products, and record data (Bybee et al., 2006).

Specifically, the teacher first raises a general question, such as: "What role does soap play in life?" Then, the teacher asks the lesson questions: (1) "How does one make soap from coconut oil?" (2) "How can we evaluate the cleaning effect of synthetic soap?" and (3) "How can we assess the impact of soap on the environment?" Afterwards, the teacher asks content questions: "What is the chemical composition of soap? How does one make soap? Can you present the process of making soap from coconut oil?"

In the first session, the teacher sets up four study groups. The session duration is 45 minutes. In this session, the teacher raises the topic of making soap from coconut oil and assigns tasks. Group 1 studies how to make soap from coconut oil; Group 2 explores the use of soap; Group 3 explores proper use and storage; and Group 4 explores the negative effects of soap on the environment, and restrictive measures. Preparation time is two weeks. Students do research, collect information from books, newspapers, the internet, etc., and then prepare necessary materials and devise a plan to make the products.

In the second session, students report the progress of their work. The session duration is 45 minutes. All groups take turns reporting the progress of the implementation of the tasks given. The teacher organizes group discussions to help solve any difficulties encountered. Then, groups try to perfect their parts and plan for PowerPoint presentations.

In the third session, students present their knowledge acquired using PowerPoint presentations. The session duration is 90 minutes. After students' presentations, the teacher allows groups to critique one another and offer counterarguments. The teacher then gives feedback and evaluation for each group. Finally, the teacher praises groups that have completed their tasks and criticizes groups and individuals that have not performed well or completed their tasks. Note that as making soap is a big STEM topic, time spent can be prolonged according to school facilities.

3.3 Explanation

The teacher encourages students to explain concepts and definitions on their own understanding. The teacher asks students to give explanations and evidence to meet the requirements. In addition, the teacher, if required, based on students' previous experience and knowledge, explains further to students. The teacher would find that students' knowledge increased (Nguyen, 2018). Students need to absorb knowledge and express their understanding through the steps of engagement and exploration either in small groups or individually (Bybee et al., 2006). The teacher teaches students about fats used for making soap. Fats include animal fats and vegetable oils. In the animal body, fat is concentrated much in adipose tissues, while in plants, fat is found in seeds and fruits.

Figure 1: Lipids (Vungoi, 2020)

Fat, a mixture of many esters of glycerol and fatty acids, has the general chemical formula: (RCOO) 3C3H5. When fat is heated with an alkaline solution, it is hydrolyzed to produce salts of fatty acids and glycerol, as seen in the formula below.

$$C_3H_5(OOCR)_3 + 3NaOH \rightarrow 3NaOOCR + C_3H_5OH \quad \ldots(1.1)$$

(Fat) (Sodium Hydroxide) (Soap) (Glycerol)

OR

$$C_3H_5(OOCR)_3 + 3KOH \rightarrow 3KOOCR + C_3H_5OH \quad \ldots(1.2)$$

(Fat) (Potassium Hydroxide) (Soap) (Glycerol)

(Okunola et al., 2019)

The sodium (or potassium) mixture of fatty acids is the main ingredient of soap, so the fat hydrolysis reaction in an alkaline environment is also called the saponification reaction.

The soap-making process is as follows. The usual method of making soap is to heat vegetable oil or animal fat (usually non-edible) with a NaOH or KOH solution at high temperature and pressure. After the saponification reaction is completed, NaCl is added and cooled. Soap separated from the solution is added and pressed into bars. The remainder, after having impurities removed, is concentrated and then centrifuged to separate NaCl salt to obtain glycerol. In addition, soap is produced by oxidizing petroleum paraffin with oxygen at high temperatures, catalyzed by manganese salts, and the acid produced is then neutralized with NaOH. The sodium salts of acids with small molecular weight dissolve easily, while the sodium salts of acids with large molecular weight are insoluble in sodium chloride solution. They are separated and called synthetic soaps. Synthetic soaps have washing properties similar to regular soaps.

The cleaning mechanism of soaps is as follows. Cleaning is defined as the process of removing dirt or dust from the surface of a solid object with a separate agent. Detergents have a different physical and chemical dissolving process than water. When immersed in water, greasy stains in fibers cannot be separated or dissolved due to the great surface tension of the water. However, if a detergent is dissolved in water, the detergent solution has less surface tension, which can penetrate deeply into the fabric and remove the grease stains. The greasy stain after being removed floats in the form of an emulsion or homogeneous solution.

3.4 Elaboration

In this step, the teacher allows students to practice making soap from coconut oil. The teacher encourages students to do research and expand their knowledge outside of the textbook when studying STEM topics. The teacher answers students' questions and concerns when asked. The teacher provides instruction and facilitates STEM deep learning. Students expand their knowledge, practice skills, and apply learned concepts and knowledge in practice.

Activity 1: Elaborate the topic of making soap from coconut oil

The goal is for students to know how to extract coconut oil and use it to make soap. Students have to establish a procedure for extracting coconut oil. The teacher hands out materials to each group to read and study.

Step 1. The teacher divides the class into four groups and organizes activities for the groups to study the given materials.

Step 2. The groups discuss and propose a coconut oil extraction procedure in which they have to select equipment, chemicals, ingredients, etc. as well as calculate ratios so as to get 100 ml to 150 ml of coconut oil.

Figure 2: 9th Grade students at Vo Van Tan Secondary School (Personal collection)

Step 3. The teacher allows groups to exchange feedback, discuss, and establish an optimal procedure.

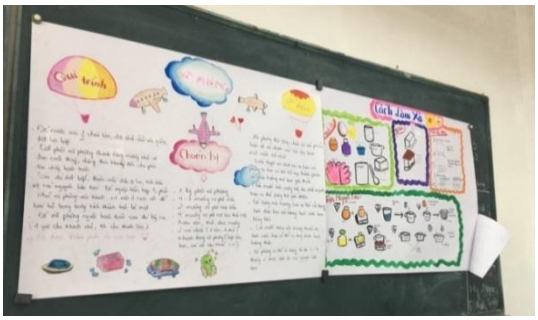


Figure 3: Student posters in one classroom at Vo Van Tan Secondary School (Personal collection)

Activity 2: Practice making soap from coconut oil

The goal is to help students map out the coconut oil extraction process as well as know how to perform some of the coconut oil extraction steps. Students are free to choose an implementation process that is most appropriate to their time and classroom conditions. First, the teacher guides students to prepare equipment and ingredients used to make soap from coconut. All students in the class have to participate in this activity. Some equipment and materials needed are presented in Table 3.

Table 3: Equipment and materials

Equipment + ingredients	Photo illustration
1 kg of old desiccated coconut (dry, hard, and white); this coconut type gives plentiful coconut oil.	 *Figure 4: Desiccated coconut (ACP, 2020)*

Alcohol lamps	 *Figure 5: Alcohol lamp (Lab Vietchem, 2020)*
Heat-resistant glass cups	 *Figure 6: Heat-resistant glass cup (Bigomart, 2020)*
Filter funnels	 *Figure 7: Filter funnel (Tanhoa, 2020)*

The teacher instructs students to proceed with the next steps.

Step 1. Add the grated desiccated coconut into 400 ml of hot water. Stir gently with a glass rod. Leave for about five minutes.

Figure 8: How to make coconut milk both fragrant and thick (DVP Market, 2020)

Step 2. Squeeze the desiccated coconut gently with a cloth to get coconut milk. After squeezing, use a filter funnel to remove coconut residue.

Figure 9: Effects of coconut water (CPCS, 2020)

Step 3. Pour coconut milk into a heat-resistant glass, then heat over an alcohol lamp. During heating, stir constantly to prevent burning and make the coconut oil clearer.

Figure 10: A student boiling coconut milk at Vo Van Tan Secondary School (Personal collection)

Step 4. Continue heating until yellow brown coconut residue appears at the bottom of the cup.

Figure 11: Yellow brown coconut residue (Personal collection)

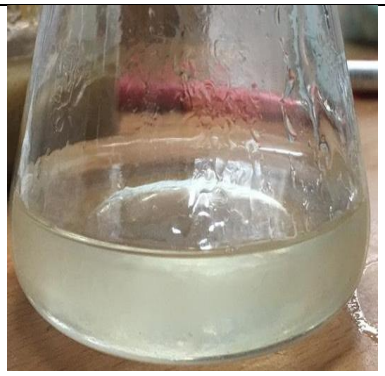
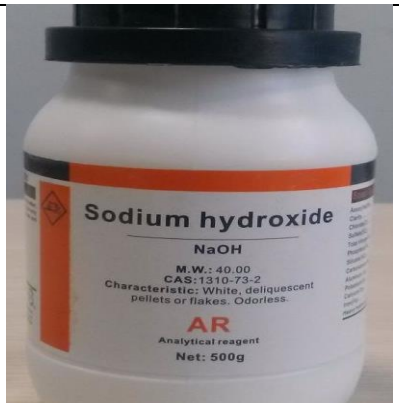
Step 5. Use filter funnels to get pure coconut oil.

Figure 12: The laboratory of Vo Van Tan Secondary School (Personal collection)

Activity 3: Make soap from coconut oil

The goal is to help students learn how to perform certain steps of making soap from coconut oil, and how to use pH paper to measure the pH of soap. Students are free to choose an implementation process that is most appropriate to their time and classroom conditions. Equipment and ingredients are shown in Table 4.

Table 4: Making soap from coconut oil

Equipment + ingredients	Photo illustration
Coconut oil	 *Figure 13: Coconut oil (Personal collection)*
NaOH	 *Figure 14: Recipe for making handmade soap from coconut oil at home (Bachhoaxanh, 2020)*

Essential oil	 ***Figure 15: Essential oil (Tinhdaukepha, 2020)***
Food coloring	 ***Figure 16: Food coloring (Abby, 2020)***
Litmus paper	 ***Figure 17: Litmus paper for pH measurement (Trang thiet bi y te, 2020)***
Mercury thermometer	 ***Figure 18: Mercury thermometer (Thegioi CongNghiep, 2020)***

Whisk	 *Figure 19: Whisk (Shopee, 2020)*

In addition to the above equipment and ingredients, there is also some other equipment, such as alcohol lamps, heat-resistant glass cups, gloves, soap molds, etc.

Step 1. Add 200 g of coconut oil into a heat-resistant glass cup.

Step 2. Add 100 g of water and 70 g of NaOH into another heat-resistant glass cup; use a glass rod to mix until the mixture starts to generate heat and light smoke. At this point, it is necessary to wait for the mixture to cool down to about 60°C.

Step 3. Boil the coconut oil at a temperature of about 70°C to 80°C.

Step 4. Mix the coconut oil and the NaOH mixture. Use a whisk to beat the mixture evenly (beat continuously for 30 minutes). Use pH paper to measure pH; if the pH ranges from 7 to 10, it meets the standard.

Step 5. Add essential oil to the mixture of coconut oil and NaOH. At the same time, spray a little alcohol to remove bubbles floating on the surface.

Step 6. Pour soap into molds as desired. Leave for six to eight hours, and then remove the soap from the molds.

Note that after the soap has been made, it should be left for four to six weeks before use. This is because the saponification process takes place during that period. It is advisable to put soaps in dry, ventilated, and neither too hot nor too humid places, otherwise they will crack, melt, or deform.

3.5 Evaluation

The teacher evaluates students' knowledge and skills, instructs them to use alternative materials if needed, discovers product uses, and expands to another STEM topic for similar products. In addition, the teacher designs a learning assessment form, including open-ended questions. Students explore new products with quality similar to existing ones by themselves, as well as ask questions to create new ideas. The teacher gives instructions in class and students do experiments at home. As students may be harmed from exposure to NaOH, they should use available soap blank instead.

The following photographs were taken of some products made at Vo Van Tan Secondary School, Ho Chi Minh City.

Figure 20: The STEM Chemistry Project (Personal collection)

Figure 21: Yellow soap blank (Personal collection)

Figure 22: Soap blank (Personal collection)

Figure 23: Pink soap blank (Personal collection)

The teacher helps students learn and explore the uses of soaps, safety precautions, soap preservation, soap effects on the environment and human beings, its restrictive measures, and the knowledge to choose the right soap for each skin type. Students study more through doing research on the internet, books, and newspapers.

Step 1. The teacher divides students into four groups, assigns tasks for each group, and establishes criteria for scoring groups.

Group 1 + Group 3: Learn about the use of soap, safety precautions, and soap preservation.
Group 2 + Group 4: Study soap effects on the environment and its restrictive measures.

Step 2. The teacher organizes activities for the four groups to study and collect information. The teacher instructs students to map out ideas on A0 paper or via

PowerPoint presentations. The teacher should give illustrations to help make the instruction clear.

Step 3. The teacher allows groups to report their collected information via PowerPoint presentations, critique one another, and offer counterarguments.

Step 4. The teacher gives feedback and evaluation for each group.

The teacher expands the topic to that of making dishwashing detergent from fruit or vegetable peels which is safe for health and environmentally friendly. The goal is to help students learn about the process of making dishwashing detergent from fruit or vegetable peels, the benefits of using organic detergents, and therefore reducing waste to the environment. Students do research and learn through books, newspapers, and the internet.

Figure 24: Turning fruit peels into detergents (Petro Times, 2020)

Step 1. The teacher distributes materials to students to find a procedure for making dishwashing detergent.

Step 2. The teacher allows students to report, and from there chooses an optimal procedure.

Step 3. Students build the standard procedure of making dishwashing detergent from fruit or vegetable peels.

Step 4. Students select peels of fruits or vegetables suitable for making washing detergent and collect them from markets or street vendors in Ho Chi Minh City, Vietnam. Fruits with and without oil should be categorized to facilitate the decomposition process.

Step 5. Students make dishwashing detergent from fruit or vegetable peels.

Rinse the fruit or vegetable peels, chop into pieces, and pile them up to 1/3 of a big container. To make fragrance, add some extra pineapple peels. Then dilute with clean water and one glass of sugarcane juice and cover the lids. Brown sugar or any kind of unprocessed sugar can be used to replace sugar cane juice.

Leave the mixture for one month to allow fermentation, then take it out and filter it into smaller handy bottles. At this moment, the mixture is ready to be used to wash dishes, mop floors, clean the kitchen, etc. Note that soft plastic bottles should be used to store the detergent, and bottle caps must be opened at times. This is to release the trapped gas produced during fermentation, helping balance the pressure inside the bottles, especially ones with an airtight lid, such as water bottles, to avoid explosion. During the process, the surface microorganisms will create a white layer of biofilm, which is very useful. Do not remove it or shake the bottles. Do not use fruit or vegetable wastes that are rotten or have fungus on them.

Step 6. The teacher allows students to report the results, advantages, and disadvantages of the process.

Learning assessment forms, which test students' knowledge of fat and understanding of the soap- and dishwashing-detergent-making process, are also handed out during evaluation.

LEARNING ASSESSMENT FORM

STEM TOPIC: MAKING SOAP

Full name: ……..

Class: ……

Group: ……

1. Procedure of making soap from coconut oil

Map out the coconut oil extraction process

……

……

……

Why do we pour alkaline solution into pure coconut oil solution (but not the opposite way)?

……

……

……

2. Do you have any questions about the soap-making procedure?

……

……

……

3. Procedure of making dishwashing detergent from fruit or vegetable peels

What are the benefits of using dishwashing detergent from fruit or vegetable peels to humans and the environment?

……
……
……
Why do we put pineapple peels in the fermented mixture?
……
……
……
How does sugar work during the fermentation process?
……
……
……..

4. Do you have any questions about the procedure of making dishwashing detergent from fruit or vegetable peels, or making soap from coconut oil?

……
……
……

In addition, the teacher asks some questions to assess students' ability to make soap from coconut oil.

Question 1. When participating in the procedure of making soap from coconut oil, what advantages and disadvantages do you find this type of soap has? According to you, is the procedure chosen standard enough?

Question 2. From the procedure of making soap from coconut oil, can you make soap from other biological materials? If possible, please give your ideas.

Question 3. Is the procedure of making soap similar to making dishwashing detergent? Why do you think so?

Question 4. In your opinion, how do the disciplines of science, technology, engineering, and mathematics contribute in the procedure of making soap from coconut oil and making dishwashing detergent from fruit or vegetable peels? Please fill out the following information:

Table 5: STEM table

Full name: ……... Group: …… Class: ……..……	
SCIENCE (S)	
TECHNOLOGY (T)	
ENGINEERING (E)	
MATHEMATICS (M)	
GENERAL CONCLUSION:	

The teacher elaborates on the procedures of making dishwashing detergent from fruit and vegetable peels. The first is that the detergent solution in water reduces the water

tension, and therefore it can penetrate deeply into the fabric. The second is the process of removing dirt. The third is the process of preventing dirt re-gathering. The fourth is that the insoluble surfactant and dirt concentrate on the foam surface are pushed out or dispersed into the solution in the suspension form. Dishwashing detergents from fruit or vegetable peels are made up of enzymes, which are proteins functioning as biological catalysts and which have the ability to speed up the rate of chemical reactions occurring in the cell. Enzymes produced by non-pathogenic microorganisms are completely harmless. Enzymes so far have had a wide range of applications in medicine, food, and light industries.

There are six 99% natural antibacterial ingredients (from fruit or vegetable peels) that help remove grease and stains, kill bacteria, clean dishes, etc. The main ingredient is enzymes extracted from fruit or vegetable peels. Each type has one or many different types of enzymes: protease, amylase, lipase, etc., all of which are effective detergents from nature, and 100% safe from harmful chemicals. Currently, enzyme dishwashing detergent is widely used. Thanks to these enzymes, dishwashing detergents are biodegradable, safe for skin and health, can clean better at lower temperatures, save energy, and contribute significantly to environmental pollution reduction.

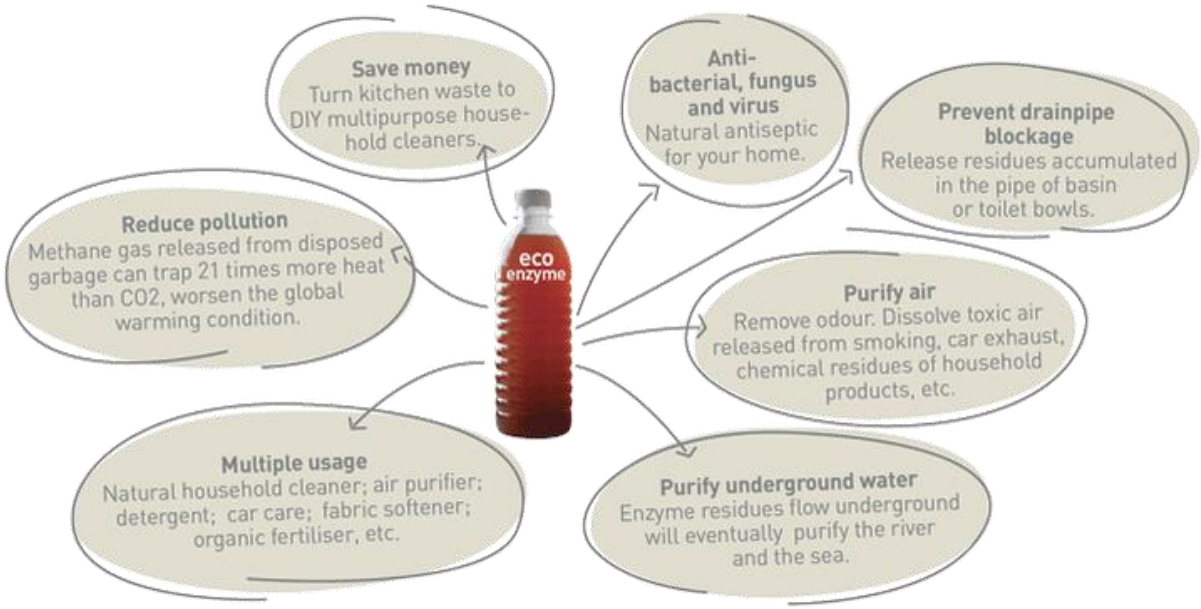


Figure 25: Eco enzyme (Minhhongbiotech, 2019)

The advantages and disadvantages of eco-friendly dishwashing detergents are presented in Table 6.

Table 6: Advantages and disadvantages of eco-friendly dishwashing detergents

Advantages	Disadvantages
– Has all uses of other commercial detergents. – Can remove grease and odor naturally.	– Requires the exact ratio of fruit or vegetable peels to sugar water. – Must be cleaned, measured, and weighed meticulously.

– Is chemical-free, safe for the hands of users, and contributes to environmental protection. – Is cost-effective and simple to make; ingredients are easy to find.	– Has the risk of failure. – Has short-term preservation. – Has less foam, thus consuming more in amount. – Takes a long time to prepare and ferment.

After completing the problem of soap making from coconut oil, students showed a passion for handmade products and a greater sense of environmental protection. They were not only interested in producing coconut oil-based room conditioners, but also began to be interested in learning about other products of the same type. By deepening their thoughts and asking questions, students come up with new STEM projects and expect their teacher to support them to improve. Projects include manufacturing dishwashing liquid from natural materials, producing shampoo using natural ingredients, or producing cleaning water with natural materials. The teacher receives useful lessons and stimulates students' motivation and their passion for discovering new things.

4. Conclusions

Vietnam is a country with plentiful coconuts, which can considerably lower the cost of coconut-based production. A coconut in Ho Chi Minh City, Vietnam currently costs less than USD0.3. Due to this abundant resource, the mass production of soap products from coconut oil is feasible and highly competitive. Therefore, STEM teaching on the topic of making soap from coconut oil is practically meaningful; it can help in both protecting the environment and preventing health pandemics. As a result, students are not only educated but also practice STEM knowledge, thus having a sense of achievement. They become engaged in their study and try hard to perfect their products in the fastest and best way. The 5E cycle model helps students thoroughly explore the knowledge and to work harmoniously in groups. After learning how to make soap from coconut oil, students can make similar products, such as dishwashing detergent from fruit or vegetable peels. This model thus helps students to be creative through problem analysis and exploration.

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