STEM education learning activity: making simple tool to produce analog rice

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Abstract. The paper will clarify STEM education learning activity of making simple tool to produce analog rice. The developed lesson plan is developed as collaboration among Physics, Chemistry and Biology teachers to address the issue on rice issue. The STEM education learning activity will be developed based on Sutaphan and Yuenyong [11] the context-based STEM education learning approach. The activity will start from identification of social issue of consumption of rice. The issue will engage students to develop projects for solutions. Consuming rice can trigger several types of diseases. Display the disease that will be suffered because of excessive consumption of rice. Starting from that thought, it would be very suitable if STEM was applied in the development of ideas related to making simple tools to produce analog rice. Through the context-based STEM education learning approach, students may motivate students to apply knowledge about physics, chemistry, and biology in order to design some technology prototypes or products through engineer design process. To design a tool for making simple analog rice, students may apply the principle of thermodynamics, classifying the nutritional content of the ingredients, and mixing the ingredients in terms of the tools. This paper may have implications for designing STEM education learning activities.

Keywords: STEM education, thermodynamics, nutrition

1. Introduction

In the 21st century, teaching and learning will lead to facilitate suitable instruction for students to practice learning from the inside of their mind and brain by based on PBL (Project-Based Learning) and apply the material in daily life in order to establish an education where students attain an understanding of Science, Mathematics, Engineering, and Technology [1], [10], [12], [13] for using their skills to create products or benefit innovation. Education gradually increases adapt at the moment focusing on the integration knowledge, especially the STEM education that allows students to be a multitasking citizen with various interests, abilities, and experiences to enhance critical skills in the 21st-century workforce (e.g., problem-solving, creative thinking, collaborative teamwork, technology literacy). The idea of STEM education was primarily raised in the United States since 1990s [2]. Recently, STEM education is flourishing in Asian nations [3], [4]. Moreover, STEM education has the main role in developing country that still needs qualified human resources to contribute to its development as Indonesia [5].
Indonesia is one of the countries that has begun introducing STEM education to spearhead education (namely to teachers, in schools). Moreover, the concept of STEM in Indonesia became popular in recent years, particularly in higher education level. It can be said that the concept is gradually developing in Indonesia [6]. The teaching and learning process in STEM realizes through blended unilaterally or one filed may be the dominant base field. Therefore, the clarification of its exact meaning very widely. These range from very specific (e.g., mathematics, physics, chemistry, biology, information sciences, and engineering) [7]. This paper focused on application of STEM education about analog rice to be alternative product ways to solve the base problem that involved with every single life of people in their country such as overcome malnutrition, a person suffering from diabetes and lacking food necessary for health and growth.

Indonesia as a large country with a wealth of natural resources and abundant human resources should be a nation that plays a great role in the development of science and technology. The Indonesian government and the country’s science educators are tasked with effectively educating diverse student groups to meet the changing needs of the country, both economically and socially. The researcher regarded that science education is forecasted the major role in preparing students to be leaders in STEM fields and to improve the citizens’ overall health and scientific literacy [8]. STEM education can be used in other scientific fields by utilizing the principles of STEM as a basis for learning and developing potential students and innovations. Innovative learning can provide students’ experience especially in promoting renewable energy in Indonesia. Learning that is able to provide direct experience can activate the hands-on and minds-on simultaneously, as project-based learning strategies has strategies that adhere to the "learning by doing", and "group learning" [9]. The activity of science and mathematics, students should combine group discussion, collaborative learning, and experimentation. Furthermore, students must gain more conceptual framework for organizing and applying what they have learned. To attain the study utilizes project-based learning that integrated science, technology, engineering, and mathematics (STEM) knowledge.

This paper aim to integrated science, technology, engineering, and mathematics (STEM) knowledge on science classroom to require the ideas from ideal tools of the activity and applied these complex task to their life. Moreover, students are more persistent in the pursuit of problem-solving based on scientific knowledge.

Indonesia is one country that makes rice as one of its staple/main foods. Based on data obtained from National Geographic, the consumption of Indonesian rice is around 140 kg per person/year, relatively higher than other ASEAN countries such as Vietnam, Thailand, and Malaysia, which consumes about 65-70 kg of rice per person/year.

Reporting from CNN Indonesia, several processes carried out on rice after harvest will reduce the nutrients contained in the rice. Rice milling and processing before marketing will make an essential part of rice can be lost. What is more, if this rice undergoes further processes such as polishing (bleaching), then vit. B, thiamine, essential fats, and other nutrients will be lost as expressed by Gargi Sharma, Weight Management Expert. Also supported by the presentation of Ritika Samaddar, Doctor Max Healthcare Saket New Delhi namely "Milling and polishing destroy 67 percent of vitamin B3, 80 percent of vitamin B1, 90 percent of vitamin B6, half the content of manganese and phosphorus, 60 percent of iron, all dietary fibers and acids essential fat". Even more dangerous if this white rice is added with various other artificial ingredients.

Consuming rice can trigger several types of diseases. Obesity is a common disease that develops in society due to consuming too many carbohydrates, which is the main content of rice and is not balanced with exercise or movement that can reduce the number of carbohydrates in the body. Carbohydrate content is also sugar that has the potential to cause diabetes. The effect that can occur when diabetes has invaded is that it can cause interference with the heart, kidneys, and other internal organs.

One solution that can be done at this time is to make a product that resembles rice with the same nutritional content or better than rice in general, namely analog rice. Analog rice is a nutritious instant food product shaped like rice made from tubers, cereals, tree plants, and fruit plants. In addition to
being a substitute for rice in general, this product has several advantages; including rich in nutrition, improve community nutrition with high protein, be developed in various regions, the making material can be adjusted to the needs, be used for food fortification programs to overcome the problem of malnutrition.

2. Developing STEM Education Learning Activity

The developed lesson plan is developed as collaboration among Physics, Chemistry & Biology teachers to address the issue on rice issue. The STEM education learning activity will be developed based on Sutaphan and Yuenyong [11] the context-based STEM education learning approach which consists of 7 stages of teaching. These included (1) Identification of social issues, (2) Identification of potential solution, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage.

Regarding on Sutaphan and Yuenyong [11] the context-based STEM education learning approach, the issue of excessive consumption of rice will be provided to engage students to develop projects for solutions. Consuming rice can trigger several types of diseases. Display the disease that will be suffered because of excessive consumption of rice. Starting from that thought, we felt it would be very suitable if STEM was applied in the development of ideas related to making simple tools to produce analog rice. Through this process, students may motivate students to apply knowledge about physics, chemistry, and biology in order to design some technology prototypes or products through engineer design process. To design a tool for making simple analog rice, students may apply the principle of thermodynamics, classifying the nutritional content of the ingredients, and mixing the ingredients in terms of the tools. The STEM education learning activity could be highlighted as the table 1.

Table 1: STEM education learning activity: making simple tool to produce analog rice

| Stage                        | Activity                                                                 |
|------------------------------|--------------------------------------------------------------------------|
| 1. Identification of Social Issue | Displays the disease that will be suffered due to excessive consumption of rice |
|                              | How to make rice substitute products?                                   |
|                              | Product: Nutritious analog rice, which is better than ordinary rice, a simple tool to make it. |
| 2. Identification of Potential Solution | Students and teachers discuss: Physics: analog rice products and simple tools (prototype) Biology: Nutrition contained (ingredients) Chemistry: The process of making analog rice |
| 3. Need for knowledge       | Physics:                                                                 |
|                              | 1. Students learn about thermodynamics, especially changes in the form of substances due to substantial temperature changes.  |
|                              | 2. Students will discuss with their groups the concept of how changes in form can occur due to changes in temperature (temperature rise)  |
|                              | 3. Activity:                                                            |
|                              | a. Students are given pictures/videos/other relevant media about changes in the form of objects that occur in life |
|                              | b. Students explain or explain the points of why these changes occur? Things that affect? |
|                              | c. Students explained the results of the discussion in every group; then, the teacher gave an explanation related to the changes in the form of substances. |
Table 1 (Continued)

| Stage               | Activity                                                                 |
|---------------------|--------------------------------------------------------------------------|
| 3. Need for knowledge | Biology:                                                                 |
|                     | 1. Students will be given pictures of what materials are needed           |
|                     | to make analog rice, such as tubers, cereals, tree plants, and            |
|                     | fruit plants.                                                            |
|                     | 2. Based on these materials, students look for what content is            |
|                     | contained in each material.                                              |
|                     | 3. To facilitate the results of the discussion, students make a list of   |
|                     | the contents in the form of a table, then present the results.           |
|                     | 4. The teacher evaluates the results of student work.                     |
|                     | Chemistry:                                                               |
|                     | 1. Students will review the results of knowledge about the content        |
|                     | of materials to make analog rice in biology.                             |
|                     | 2. Students discuss how to mix some of these materials to make and        |
|                     | shape them like rice using physics knowledge; students are expected to   |
|                     | find a solution to how the effect of rising temperatures on changes in   |
|                     | the form of substances and then apply to the changes in the form of      |
|                     | materials needed.                                                       |
|                     | 3. The teacher explains the change in the form of the ingredients that   |
|                     | have been mixed with the contents contained therein. After that, it      |
|                     | explained the heating process with high temperatures that can change    |
|                     | the form of substances, making it easier for mixing and forming rice.    |
| 4. Decision making  | Physics:                                                                |
|                     | 1. Students design a simple tool using the principle of Thermodynamics.   |
|                     | 2. They make a scheme of how the tool works in paper form.                |
|                     | Biology:                                                                |
|                     | 1. Students are assigned to classify the nutritional content of the       |
|                     | ingredients that will be used in making analog rice.                     |
|                     | 2. Students think whether there are additional compositions that are      |
|                     | useful for making analog rice, explain in paper form.                    |
|                     | Chemistry:                                                               |
|                     | 1. Students design the process of mixing the ingredients in terms of the |
|                     | tools that have been designed and the nutrients contained.               |
|                     | 2. They make paper related to the scheme of mixing materials and the      |
|                     | final results of analog rice obtained.                                   |
Table 1 (Continued)

| Stage | Activity |
|-------|----------|
| 5. Development and prototype or product | **Physics:** Students explained in front of the class by including pictures or designs of tools to make simple analog rice  
**Biology:** Students analyze the content contained in analog rice if mixed with certain ingredients in terms of the amount of nutrient content of ingredients per gram.  
**Chemistry:** Students describe the process of mixing ingredients from simple tools to make analog rice, as well as the techniques employed to form the mixing material so that it is shaped like rice in general. |
| 6. Test & Evaluation of the solution | **Physics:** Students develop ideas about: What is the temperature needed for substances to change the form?  
**Biology:**  
1. The teacher will review the contents of the mixing of materials that have been designed by students; then the teacher gives feedback.  
2. Is analog rice content better than ordinary rice?  
**Chemistry:** Students answer problems about:  
1. An effective way to form mixing ingredients to resemble the shape of rice in general.  
2. If implemented, how much would it cost to make simple tools? |
| 7. Socialization and completion decision stage | 1. Each group completed the final form of a simple tool in making analog rice by utilizing a design application (Corel, Photoshop, Macromedia Flash)  
2. Each group presents the tool design, manufacturing process, and content contained in analog rice.  
3. Each group makes a report in the form of a *Project Creative Book* |

3. Conclusion

This paper showed how to provide STEM education through team teaching based on Sutaphan and Yuenyong [11] context based STEM education learning approach. The identification of social issue provided consumption of rice to engage students to develop projects for solutions. And, physics, chemistry, and biology class will support students to find the possible designing solutions regarding on the physics, chemistry, or biology content. In physics class may allow students to design about a simple tool for producing analog rice which requires knowledge of thermodynamics. In biology class will enhance students to classify the nutritional content of the ingredients that will be used in making analog rice. In chemistry class, teacher will enhance students to develop their designing for the process of mixing the ingredients in terms of the tools.  

In test and evaluation of the solution stage, it allows students to apply knowledge about the temperature needed for substances to change the form to produce analog rice. The biology knowledge
also will be applied for evaluating the prototypes when students will be remind to review the contents of the mixing of materials and how to prove if it is better analog rice. In the socialization and completion decision stage, students need to make a report in the form of a Project Creative Book for presenting their prototypes or products. Then, the human need will be considered for validating and improving the better analog rice. This may share some ideas of how to develop STEM education learning activities through team teaching in school setting.

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