Eco-friendly fashion: A STEM sandpit project in Indonesian senior high school

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Abstract. The paper will clarify the learning activities of eco-friendly fashion STEM education lesson plan. The activities were designed based on Sutaphan and Yuenyong [11] context based STEM education learning approach. This learning activities aim to foster student think profoundly in investigating the current new challenge (control the growth of the wasted clothes using an eco-friendly fashion system) in the society using STEM approach and the sandpit research or project as the model. The paper will discuss how to provide students chance to applying STEM knowledge through these activities.

Keywords: STEM education, fashion, ecosystem

1. Introduction

STEM is a teaching approach which refer to the disciplines of collective within its stands for science, technology, engineering and mathematics and also to a cross-disciplinary approach to teaching that increases student interesting and improves students’ problem solving, critical thinking and analysis skills in STEM fields. STEM education is not aimed to a harmonious integration between content knowledge and teaching knowledge but focusing on the problem-based activities. The focal point of national strategy is an action that lifts foundational skills in STEM learning areas to encourage the development of the 21st century skills of citizen. Furthermore, STEM education is not only integrate students who understand the content or teacher’ pedagogies to convey the content but also lead students to learn, think and answer the problems in their own daily life by taking action (learning by doing) and have a process of testing their own ideas with trial and error. Moreover, they will receive their feedback from self experimentation as viewed involves all strategies that are put in place to create opportunities for people to learn throughout life by providing both the individual need and that of the relevant community [1], [9], [12], [13]. Consequently, STEM teaching does not focus on the content that students will receive but focusing on the application of that content in daily life. It recognizes the importance of a focus on STEM in the early years and maintaining this focus throughout schooling [2]. In the 21st century, we focused on the preparing knowledge for globalization, information society, the expansion of the technology services industry, competition in the economy, and workforce needs to be creative. The future world, STEM education has been running for the program that can help student to foster various strategies in tackling interdisciplinary
problems and competitive advancing tasks on their life. Thus, students cultivated the thinking skills by scientific knowledge in the future.

The teaching of STEM in Indonesian high schools, Suprapto [3] stated that the concept of STEM in Indonesia became popular in recent years, especially in higher education level. It can be seen that the concept is gradually developing in Indonesia. Basically, researchers present their studies, meanwhile the improvement of STEM education which is suitable for characteristics in Indonesia should be published. Specifically, more journal analyses can enhance other researchers to broaden their knowledge about STEM education in Indonesia [4]. Columbia Global [5] revealed that they had the project in 2012 which are focuses on building capacity at teacher training colleges and schools that will serve as models in Indonesia. Currently, STEM learning is not only involved with children and adults in schools but also set to variety of contexts such as the home, community-based activities, after-school programs, the workplace, museums, science centers, zoos and aquariums, as well as across a wide range of digital media [6]. Thus, the learning STEM activities create with local learning resources in the school and around the community. In STEM education, students will not learn about 4 topics at the same time but they will learn more about customs traditionalism and folklore.

On the other hand, many skilled workers in Indonesia come from other countries. They enter Indonesia to compete for jobs. Many sources considered those countries a representation of developed countries and had great inventions in STEM education. Actually, policy makers can recognize the changes. Unfortunately, Indonesia is at risk. It can be seen from the social and economic condition in some parts of Indonesia. The data show that PISA level is still low [4]. Moreover, the country’s results in international standardized assessments of student achievement have been poor relative to other countries including in Southeast Asia.

This study will lead students to Design-based learning thought STEM activity to investigate students’ creative by looking the source of community that could integrate and advocate effective creativity within activity. On this lesson plan, researcher will guide students consider to be an essential element of problem solving, critical thinking, science, and engineering design on their task. The STEM education encourage students on tasks with real-world problems [7], [8], [10], [11]. Consequently, Indonesian students should gain the opportunities to choose STEM field as their life carrier would require immense endeavor since the carrier pathway in Indonesia highly correlated with the social and cultural discourses. The main goal of this STEM education learning activity is to integrated students with the current new challenge (control the growth of the wasted clothes using an eco-friendly fashion system).

2. Developing Eco-friendly fashion STEM Education Learning Activities
This learning activities aim to foster student think profoundly in investigating the current new challenge (control the growth of the wasted clothes using an eco-friendly fashion system) in the society using STEM approach and the sandpit research or project as the model.

The lesson plan was developed on concept of Context-based STEM education learning approach which the STEM education learning activities should provide not only the ways of investigation and solving problem but also a real world problem solving. Regarding on Sutaphan and Yuennyong [11], the context-based STEM education learning approach 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 the 7 stages of context based STEM education teaching approach, the activities could be started from teacher pose an issue to be solved by the students “control the growth of the wasted clothes using an organic fashion system”, then the teacher asks, “What kind of eco-friendly fashion that your group will make? Please design a new project to cope with the issue. The 7 stages will allow students using applying scientific and other knowledge for designing the solutions, and provided the context of instruction requires solving a real-world problem or task through teamwork. And, students will have also chance to apply their scientific and other
knowledge for problem solving in context of engineers, technology, or entrepreneurship [11]. The core activities could be viewed as showed in the Table 1.

Table 1: Core activities of eco-friendly fashion STEM Education

| Stage | Activity |
|-------|----------|
| 1. Identification of social issues. | Stimulating the group producing a new idea, teacher asks students to identify the social issues first related to the cons of wasted clothes (e.g. water and soil pollution, facilitating people who are easily bored by the current style). The local issues will be provided as following. The traditional cloth from South Sulawesi, recently, become more attractive among tourists. This cloth is unique because it is made from the tree bark. The tree bark cloth can also become a solution to decrease pollution created by wasted cloth, because it can be easily degraded by bacteria. However, it can take two months to produce one cloth. Moreover, the local people produce the old-fashioned and bored style, thus it needs to be modified. |
| 2. Identification of potential solution. | Creating an eco-friendly fashion system will be the best solution to deal with those issues. (In this activity each group should decide first, what kind of fashion or clothes that they will make) Teacher may provide questions which enhance to learn related knowledge of designing. The big question will be: How to produce a tree bark cloth with a shorter production period and more fashionable style? Then the question breaks down to be: What are the materials should be prepared? What should be changed from the traditional technique production? How is the current favorite style of the society? |

![Figure 1 South Sulawesi Tree Bark Cloth](image)
Table 1 (Continued)

| Stage                        | Activity                                                                                                                                                                                                                                                                                                                                 |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. Need for knowledge.       | Because of the group consist of a heterogeneous expertise, thus the idea would be richer rather than the homogeneous one. Each member of the expert in the group can convey their own idea based on their expertise. For example, in a group consisting a biologist, chemist and engineer. The biologist possibly would share his idea about the natural coloring material for the clothes, the chemist could decide what is the organic material for the clothes or shoes, whereas the engineer can design or process how it could be produce and the other expert can share the other ideas. Due to the fact that this project will be administered to the third grade (XII) of senior high school, thus the students must have enough competencies in integrating some concepts to conduct the STEM project. For instance, the natural coloring concept or discourse should be attained when the students studied plant diversity and the structure of plant in the 1st grade biology module, thus teacher only can prompt students’ prior knowledge about natural coloring. In addition, the organic and inorganic substances were taught in the 2nd grade chemistry module. Hence, to estimate the production period and the produced cloth amount student have to think mathematically. The math concepts could be the basic algebra. |
| 4. Decision-making.         | Before the group reporting their project plan, they have to decide which of those ideas that should be executed and which one that should be eliminated. They have to consider the pros and cons of each idea, then rank it. The only best idea which should be bring in the project.                                                                                                                                                                           |
| 5. Development of prototype or product. | After deciding the project plan, they have to make a prototype. For instance, creating a shirt from tree bark (Fig. 1), bag, or shoes which will be easily digested within the specified time, for example 1 year.                                                                                                                                                                                                                     |
|                             | Then, each group presents their own prototype in front of the class.                                                                                                                                                                                                                                                                                                    |
| 6. Test and evaluation of the solution. | There are two types of the test or evaluation that can be conducted.  
  • Firstly, from the teacher, he/she can test or evaluate the students by commenting their project based on analyzing the STEM’s capitals - physical, financial, social, human and natural- also can be evaluated using the creative thinking’s elements - fluency, flexibility, originality and elaboration-.  
  • To make the evaluation process much easier and less boring, teacher probably can make an evaluation rubric using the indicators from the STEM’s capital and creative thinking skills’ elements.  
  • Lastly, the other groups can also comment about the other groups’ project.                                                                                                                                                                                                                                         |
Table 1 (Continued)

| Stage                                                                 | Activity                                                                                           |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 7. Socialization and completion decision stage.                      | After having some comments from the teacher and the other groups, each group refine their design then executing it with realizing their product and promote it to the public. |

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 local issue of controlling the growth of the wasted clothes using an eco-friendly fashion system will be challenged in order to motivate students find solutions of their STEM problem solving. The traditional cloth, from South Sulawesi, will be introduced to the class as a possible solution. This cloth is unique because it is made from the tree bark. The tree bark cloth can also become a solution to decrease pollution created by wasted cloth, because it can be easily degraded by bacteria.

Regarding to the eco-friendly fashion system issue, students may engage to conduct the STEM project. Then, they may need related knowledge for their designing; for examples, coloring material for the clothes, the organic and inorganic substances, and to estimate the production period and the produced cloth amount student have to think mathematically. Students’ designing based on ideas of easily digested within the specified time could challenge students to make a prototype through applying various kinds of knowledge and concern. To test or evaluation of their prototypes, they will ask about analyzing the STEM’s capitals -physical, financial, social, human and natural; and creative thinking skills’ elements which would be reminded to revise their STEM projects. This may share some ideas of how to develop the local product STEM education learning activities in school setting.

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