A Concept: Implementation Of STEM Literacy through Project-Based Learning in Briquetting Process for Junior High School Class 9 Semester 2

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Abstract

STEM is one approach in the learning process that is being developed today. Opportunities to integrate the concepts, principles, and techniques of Science, Technology, Engineering, and Mathematics in the student's life system become larger. The aim of this review is to study the STEM literacy and its application in learning. Learning with STEM approach that can be done in junior high school students one of them with subject Environmental Technology taught in grade 9 semester 2. Implementation of these stages in the subject of Environmental Technology in accordance with indicators of learning achievement. Students can create projects about making renewable energy such as biobricket. Based on the results of the study, it can be concluded that STEM literacy can be applied in Indonesia with the learning of Integrated Science based on the project.

Keywords: 21st learning, STEM literacy, project based learning, biobricket project

Introduction

The benchmark of the progress concerning a nation is seen from the level and quality of education of a community. In 2015, the Trends in International Mathematics and Science Study (TIMSS) conducted a study comparing student achievement in various countries in the field of mathematics and science, presenting Indonesia results ranked 45 out of 48 participants who followed this survey with a score of 397 (Provasnik, 2016). In the level of science literacy tested by PISA conducted every three years shows Indonesia is ranked the lowest ten of all countries that followed the survey. Indonesia's score in 2012 was 327 and in 2015 it increased to 359. Despite an increase from 2012 but the score is still far below the average of other countries. If able to maintain the effort that has been done then in 2030 Indonesia will be able to catch up the score (Kemdikbud, 2016). One important aspect of PISA assessment is the student's science literacy.

Furthermore, Ardianto (2016) describes the results of the PISA analysis on the results of the science literacy students found that

1. Low student science literacy has an average score of 32% on all aspects, including 29% of content, 34% for processes, and 32% in context
2. The difference in literacy ability of science students in each province is equally low
3. The ability to solve problems for children in Indonesia is very low, far below Malaysia, Thailand, and Philippines.

Science literacy is one's ability to understand the science used in identifying new knowledge, applying science in problem-solving related to science issues, communicating science and making decisions based on scientific considerations (Toharudin et al., 2011; PISA, 2010). The scientific ability of literacy is able to explore the students' experiences in developing the problem to be solved through investigation therefore that new knowledge will be obtained. It develops the students' skills needed in the 21st century, consisting of broad insights, thinking skills, leadership skills, bilingual proficiency, ethics and spirituality, and also nationalism (Sikas, 2017). The development of such skills is influenced by the application of the models, methods, and learning approaches used. STEM is one approach in the learning process that is being developed today. STEM is an acronym for Science, Technology, Engineering, and Mathematic that is defined in the integration of the four concepts into educational techniques to help the realisation of 21st-century education skills by focusing on solving real-life problems. Opportunities to integrate the concepts, principles, and techniques of Science, Technology, Engineering, and Mathematics in the student's life system become larger. (Becker et al., 2011; Beers, 2011; Rustaman, 2016; Reeve, 2013).

STEM is being developed to be implemented in Indonesia, one of which is STEM-based science learning process in junior high school students. This is prepared because learning by using STEM-based Student Worksheet studied by Suwarna et al (2015) can improve motivation and provide direct experience to students of Pertiwi (2017) explains that learning by using STEM-based Student

worksheets is effective in training students' learning skills, it is necessary to study the STEM approach and its application in learning.

Result and Discussion

The current educational development is in line with the development of human resource needs required in the development of knowledge and improvement in the field of economy. Skills in science, technology, engineering, and mathematics in the development of science encourage the creation of an approach to the learning process that can integrate those skills. Development of STEM-based education develops learners in developing *STEM literacy* with details (Bybee, 2013):

First, learners are expected to gain skills, have the attitude and knowledge in identifying problems, designing, and drawing conclusions in phenomena in everyday life related to STEM.

Secondly, it understands the special characteristics of the STEM discipline as an effort in construct knowledge, forming inquiry, and skills on STEM.

Third, gain awareness to create a material, intellectual, and cultural environment compatible with STEM disciplines and concepts.

Fourth, having a conscious and concerned attitude regarding STEM issues (eg energy efficiency, environmental quality, limitation in the natural resource) in people's lives, conveying ideas as an attempt to find solutions.

STEM literacy in accordance with the standard of skills that students need to have under the National Research Council (Suwarna, 2015) standards. These skills are skills to adapt to various conditions, the ability to process and interpret information both verbally and non-verbally, the ability to solve unusual problems, the ability to work automatically both in groups and individually, the ability to understand the workings of the entire system, understand about the effect of an action and its changes to the system (NRC, 2010). Application of STEM integration in education certainly has a good impact not only on students but also on teachers. Teacher confidence is very influential on the success of teaching. Not only is it influential in improving students achievement, teacher efficacy also improves student motivation, self-esteem, and more positive attitude in class and school (Caprara, et al. 2009; Stohlmann et al., 2012).

STEM-based education has the characteristics to integrate science, technology, engineering, and mathematic to develop the quality of human resources appropriate to 21st-century skills which have been customising applicable curriculum, therefore, the students will be able to analyse and solve real-life problems (Roberts, 2012; Ismail et al., 2016). Various ways to teach the four areas of STEM science, as described by Rustaman (2016) the first way of separating the four areas into separate subjects so that they are not integrated, the second way is to teach one or two of the STEM disciplines, the third way with Integrating one discipline into three and the fourth way is to integrate all STEM disciplines into one field of study. The fourth way is a way to actualize the actual STEM, but the implementation of the fourth way in the school curriculum in Indonesia is relatively difficult to implement thoroughly, especially in primary education (Bybee, 2013; Rustaman, 2016).

Learning with STEM approach that can be done on junior high school students one of them with subject Environmental Technology taught in grade 9 semester 2. In the material have an indicator based on *Permendikbud* No 58 Year 2014 as follows

- Identify technological differences that are Environmental and technologies that are not Environmental
- Explain the principles of Environmental technology
- Identify Environmental technologies around the student's residence
- Describe the positive and negative impacts of technology implementation around students' living quarters
- Formulate ideas or suggestions to address the negative impacts of technology implementation around the student's residence
- Describe examples of Environmental technologies in the areas of energy, transportation, environment, and industry
- Identify energy-saving behaviours that are easy to do in everyday life
- Explain the principles of Environmental technology
- Identify alternative energy sources that exist around the student's residence

- List the advantages and disadvantages of applying alternative energy sources around the student's residence
- Determine which alternative energy is most appropriate or most likely to be applied in the environment around the learner

Implementation of subject Environmental Technology with STEM approach is done with learning by project, students will arrange project related to problem-solving and innovation in the project. STEM learning stage based Ferdiansyah (2015) divide it into several stages namely

1. Stages of observation
2. Stages of discovery of new ideas
3. Stages of innovation
4. Stage create

Implementation of these stages in the subject of Environmental Technology in accordance with indicators of learning achievement. Students can create projects about making renewable energy around students. Stages of learning that will be done can be seen in Table 1.

Table 1. The design of the STEM learning stages in subject Environmental Technology

Step	Description
Observation	The first stage of the students by identifying the differences in Environmentaland Technologies used and in accordance with their living environment is related to the phenomena of science, technology, engineering, and mathematics
Find New Idea	Describing new ideas derived from the observations, explaining how they work therefore that students will learn to think processes and improve skills in conducting an analysis of the energy change process of the product to be formed
Innovation	Students should be able to provide different innovations from existing similar products, deciding out their superiority
Creation	The last stage in learning. Students are asked to be able to realise the design so that it can be applied

One source of renewable energy that can be used as a project for students is the processing of briquette because the procedures and stages are simple and able to develop students. Briquette is made from biomass that is a living thing residue that usually comes from animals and plants that have cellulose (Shukla, 2015)

therefore biomass processing can be converted into briquettes through briquette process. Briqquetting is a technology that can increase the density value of cellulose with a small material size (Murali et al., 2015). Briquette is used in both rural and urban scale as fuel in cooking also in industrial activities (Maninder, et al., 2012).

Procedures for making briquettes as project materials for students can be done based on research (Ratri 2012) and adapted to the stages of the STEM learning design shown in table 2.

Table 2. Briquetting steps adjusted for STEM learningStep of making STEM learning stage

Briquetting steps	STEM learning stage
Choosing and searching for raw materials (materials containing cellulose) and adhesives (serves to glue briquette particles) available around students	Observation
Students determine the materials to be used in making briquettes, determining how to make briquettes	Find idea
Students innovate both in terms of materials used and the work of making briquettes made	Innovation
Students perform the process of making briquettes and test the combustion to see whether the innovations made give better results or not	Creation

Learning with STEM approach based on the project can create students who are able to think critically, creatively, and have a high level of analysis. STEM approach development continues to be done in the implementation of learning so that later will be obtained students who have graduated from the educational unit able to work according to the field of STEM so the fulfilment of human resources STEM in Indonesia can increase.

Conclusion

Based on the results of the study, it can be concluded that STEM-based approach can be applied in Indonesia with the learning of Integrated Science based on the project of subject Environmental Technology Class IX Semester 2. Stages of

learning are done through observation, find a new idea, innovation, and creation steps so STEM-based learning in process briquetting therefore it can improve students to think critically, creatively, and analytical skills.

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