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THE LEARNING OF THE SOLAR CELL ELECTRICITY AMONG THE STUDENTS IN JUNIOR HIGH SCHOOL

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ABSTRACT

For about eight hours per day, Indonesia is always illuminated by the sunlight because of its position in the equator. The sunlight in general is still used conventionally for the drying process; it is natural since the educational process of the use of the sunlight is not optimal yet. Water heater with solar cell energy starts being used in cities, especially those serving as the accessories in the bathroom. Moreover, the solar cell energy is also used for traffic lights and street lamps. At present, the people still think that the last two examples merely belong to the people with great budget or those with high scientific capabilities. In this present paper, the solar cell energy would be one of the materials studied in the learning of craft in Junior High School, especially Class 7. This learning would provide the students with some abilities in understanding the solar energy, how the sunlight is conversed into electrical energy. Then through an inquiry approach, the students assembled the solar cells to produce electric energy. At the last stage, the students were able to store the electricity from the solar energy into batteries and make use of it in daily life.

Contribution/ Originality: Indonesia is one of tropical countries; therefore this paper contributes to solar energy learning for junior high school students in this country. Learning is given not only theory but the practice of craft lesson. This lesson provides life skills for everyday life.

1. INTRODUCTION

Energy is a global problem because the reserve of energy (from fossil materials) is decreasing meanwhile the consumption is increasing. For example in East Kalimantan province the reserve of crude oil is estimated to run out in 2028, while the natural gas in 2042 (Heyko and Hasid, 2016). To anticipate the situation, various efforts have been being made for instances by saving the energy and also looking for sources of alternative energy. At present, much has been reached in the development of the search for the sources of the alternative energy such solar energy, wave energy, nuclear energy, biomass energy and the like. The energy that mostly paid attention to now is renewable energy.

Responding the problem of energy, the government of Indonesia through the President' Instruction No. 10/2005 has instructed energy saving. Moreover, through its ministry namely the Ministry of Research and Technology the government also launched a long-term program on the renewable energy that should be developed

until 2025. European countries have made the efficiency energy by improving the renewable energy up to 20% (Zervos, 2009).

It is right that the problem of energy in Indonesia is the responsibility of the government but the people may also support to solve the problem in accordance with their capacity. The educational world has a great chance to help support the solution of the problem of energy through learning at school (Cholily *et al*., 2017). The learning of energy is still limited to the understanding and its changes. Therefore, it is necessary to develop the learning into the discussion of the potency of energy in Indonesia and also the opportunities of energy exploration by making use of the nature giving prominence of the environmentally friendly aspects. Clearly, the learning of energy should be led to the saving of energy although in small scales. It is through this type of learning that students are expected to have a better understanding of the energy literacy in a correct way and with the future insights of especially environmentally friendly energy.

2. RENEWABLE ENERGY

The term energy may simply be thought as anything that may move something. Human beings, animals, and plants need energy to be active and to grow. On the other hand, energy also exists in all things such human beings, animals and plants and more importantly in this nature such as the sun, wind, water, garbage and the like. What part of nature has/has not been made use of as the source of energy? This question might be able to trigger the optimization of the nature to produce energy.

Referring to the 2013 curriculum it is seen that the material of energy starts to be taught in Class 7. Widodo, in their student's science book explain that energy is the ability to make efforts (works) or a change (Widodo, 2006). Moreover, the forms of energy and its examples are also presented in the book. In this kind of book, the materials on the sources of energy and how to change the energy into other forms of energy should also be added. The addition of such materials may inspire students to look for alternative energy to avoid any dependency on one energy material.

The dominant source of power plant in Indonesia is coal which is still abundant in Indonesia. But a simple question may be asked: when this natural source will still be used? All motor vehicles on the streets use the basic materials of crude oil: premium, pertalite, pertamax and also diesel oil. It means that the reserve of the crude oil is continuously explored and this causes the reserve of crude oil to reduce.

At present in all over the world the sources of energy still mostly depend on those available in the nature such as oil, coal, and gas. Motor vehicles like planes, cars, power plans all use the fossil oil. The society in general have realized that the formation of such a kind of natural energy needs a very long time, millions of years (Ferry and Monoian, 2012) and it is predicted that the energy with the basic materials from fossils once will run out (Simanjuntak, 2005). Due to the fact that the sources of energy decline, many scientists have been looking for other sources of energy and also the sources of renewable energy. In the past, people cooked their foods using firewood, and the steam trains also made use of firewood. From the cleanliness, firewood as fuel is not as clean as gas or oil. But, trees as the materials of firewood can be planted easily and may grow quickly. Wood in this case is included into one of the examples of the source of energy that can be renewed or popularly known as the source of renewable energy. Scientists are searching for this kind of the sources of renewable and environmentally friendly energy.

Indonesia is one of the countries that is located in the equator which means that it is a country in the tropical area. It has rich natural country with abundant sources of renewable energy. The sun, the sea, the wind, geothermal, hydropower hydrogen, bioethanol. Coal biomass are some richness possessed by Indonesia and they may use as the sources of energy, but there some potentials that have been made use of well such as oil, coal and gas. Therefore, it is necessary to optimize the uses of other sources of energy.

3. SOLAR ENERGY

The sun is the source of life. Heat of the sun makes the living creatures able to continue their lives. Plants may do their photosynthesis and produce oxygen human beings need. Through the heat of the sunlight, a cycle of water, cloud and rain occurs. Human bodies also need the heat of sunlight to change pro-vitamin D into vitamin D. There are still a lot of the benefits of the heat of the sunlight that need to be explored well.

The sun radiating its heat and light to the earth is the source of a very great energy. Indonesia as a country located in the equator is one of the countries in the tropical area and a country imbued with a great amount of constant sunlight. From the West to the East area, the average radiation of the sunlight in Indonesia is 4.8 k Wh/m²/day with variation of 9% per month (Lubis, 2007). This good sunlight is the source of abundant energy and therefore, all the concerned parties should give a great attention in the use this energy.

According to each one-meter square of the earth surface accepts up to 1000 watt of the sun energy and less than 30% of this energy is reflected again to the outer space while 70% is absorbed by the cloud, the sea and the land. Based on the fact, Indonesia should seriously make use of this solar energy. This solar energy should be handled from all lines by the research institutions and higher education institutions and that is more important is to educate the people in using this kind of energy.

Indonesia possesses a strong base to develop this solar energy on the basis of the National Energy Policy (KEN-2050). The policy explains that the development and the use of renewable energy (including the solar energy) are given a priority. If this policy can be conducted consistently the Solar Home System Program and also the Energy-Independent Village Program once launched will be able to be realized.

A long-term development of the solar energy is in a great need. This need is triggered by the condition of energy and electricity in Indonesia which is still dependent upon the fossil basic materials which later must run out. With its strategic position in the tropical area, Indonesia should always develop the solar power technology as the source of electricity. For a large scale, it is necessary to develop the solar power energy technology, but what is also very vital is to education the people on how to develop the solar energy for each household to reduce the consumption of electricity coming from the State Electricity Company (PLN).

4. THE LEARNING OF SOLAR CELL

The planning of the learning of solar cell greatly depends on the existing curriculum. this learning curriculum has been being developed which at first it was considered as a group of subject matters (Sanjaya, 2008) but now it becomes the students' learning experiences (Sukmadinata, 2008). Curriculum should be organized with the basic concept of meaningful learning. This helps and facilitates the teachers and the students to attain the goal of the curriculum.

A curriculum should always follow the development and the demand of an era. Therefore, the 2013 curriculum was designed to empower the students' competences from their knowledge, skills and attitudes. This gives opportunities to the actors of education to adapt their curriculum to its environment. This idea certainly refers to the Regulation of the Minister of Education and Culture No. 58 (2014) stating that the local load in the curriculum contains the craft subject matter. Stated that it is probable to give the subject matter of the solar panel energy through the craft subject matter in the curriculum of secondary schools (Cholily *et al.*, 2016). The students are not only introduced with theories but also practices of how to assemble the solar panel and to directly see the existence of electricity in their craft.

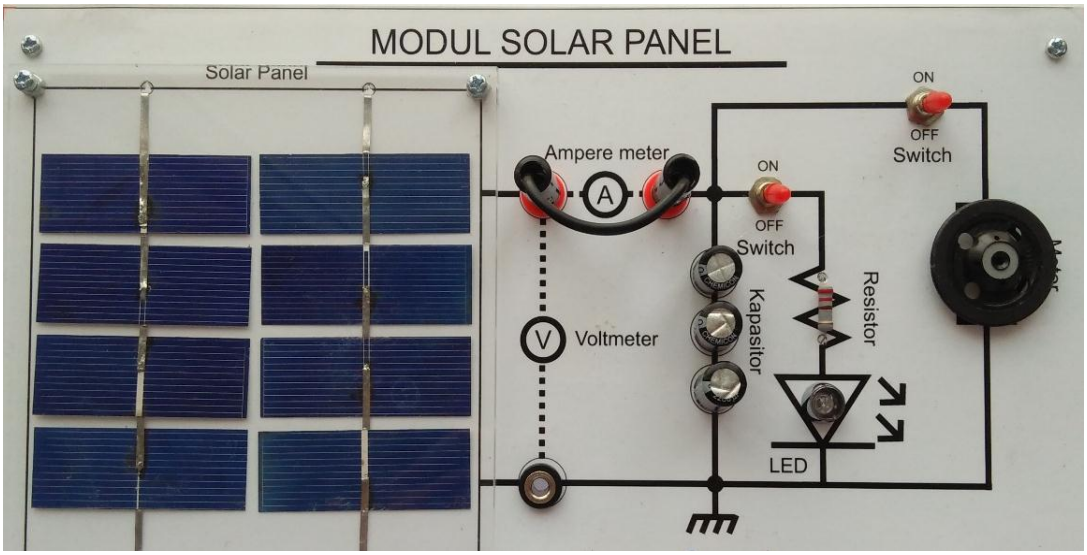
From the descriptions above, it is clear that the sun gives a great energy. But it is a pity that it is merely limited as the knowledge for the students. Therefore, the education of the solar energy should be reformulated. At the Junior High School level, the solar energy education is till merely at the knowledge level instead of at the practical level for the students. Explained that it is necessary to teach the solar energy through the solar panel to

the students at this school level (Cholily *et al*., 2017). The craft subject matter is one of the media to give material of the solar panel to the students.

The "prakarya" subject matter may say to be the craft subject matter which in essence leads to the work of mind and hands to produce a work. Definitely, the term "prakarya" in the teacher's book (Kemendikbud, 2014) is an effort to obtain skillful, quick and proper competences through the learning of *craft*. The craft subject matter has a principle to unite knowledge and physical skills. In essence, the learning of craft is intended to improve the nation's character education. The area of Indonesia ranging from the west (Sabang) to the east (Merauke) certainly possesses a unique characteristic for each area. This results in the learning of craft in an area to be able to be different from others. But, the learning of craft as an effort to educate the nation's character should also follow the development of technology and produce works of local areas and refer to the creation of appropriate technology (Kemendikbud, 2014). The territory of Indonesia from the west to the east has the same position namely it is located around the equator. The intensity of the sunlight in this tropical area is stable all the year around which scientifically can be determined to be 8-8 hours each day. At the range of time, the sun reaches its maximum intensity for 4-5 hours per day. The use of the heat of the sunlight up to now is just for the natural drying process. Therefore, it is necessary to educate the people to optimize the use of the sunlight. This kind of material may also be found in the formal education namely on the subject of the changes the solar energy into other forms.

That there is an opportunity for the learning of craft to discuss about the electric energy and the solar panel (Cholily *et al*., 2017). It is supported by the present condition where there have be a lot of products that deal with the solar panel such as the park lamps, electric charger for hand-phone and also power bank. Moreover, there are also a lot of solar panel modules with small shape sold in the free market as the media for the learning of craft. An easy way to get the modules certainly gives some opportunities for the world of education to apply the learning of solar panel at school.

There are four components that should be introduced at the world of education at school although it is sometimes not necessary for the students at the Junior High School level to be familiar with them. The four components are a) solar panel; b) battery; c) controller and d) inverter. Solar panel or *photovoltaic cell* is a semi-conductor consisting of a circuit of diodes that may change the sunlight into the electric energy (Brian, 2015). A learning medium make merely consists of a circuit of micro solar panel and a load in the form of an LED lamp and also a dynamo that may be used to show the students about the existence of electricity from the solar panel if it is exposed to the sunlight (Picture 1).



Picture-1. Learning Medium for the Solar Panel Medium

Recently, the solar energy has attracted many researchers because it is thought as a source of a relatively clean energy or called green energy. Certainly, the sunlight only exists during the day. Therefore, it is necessary to think how to save the energy of electricity from the solar panel into the storage medium namely battery as the reserve of electricity at night. There are many kinds of battery from AA, AAA, power bank to large scale battery known as accumulator. All types of battery have the same function namely as the tool for storing the direct current electric power. The sunlight exposed to the solar panel produces electricity that us then stored in the accumulator. How to store electrical power into the battery should be designed at learning activities. The students are asked to directly practice to assemble this kind of short modules.

Solar charger controller is an important solar panel module for the circuit of a complete solar panel. This tool functions as a gate to control the traffic of voltage from the solar panel, the battery, and the load. Moreover, it also serves as the automation of activities during the charging and the use of the battery. The battery life may be optimized because of the existence of this solar charger controller.

There are four functions of the solar panel controller: a) as the voltage controller; b) as the battery voltage controller; c) maintaining the reversed current and d) managing the current to the load. Each battery possesses a capacity which is in line with its capacity. This solar panel controller controls the voltage from the solar panel entering into the battery so that it will not exceed its capacity that may result in the destruction of the battery cells, which is in general is marked by the distending battery. The second function is to manage the condition that if the voltage of the battery decreases, this tool automatically will stop the load of the battery so that its power will not run out completely. At night, certainly no sunlight exposing to this tool is received so that the solar panel will not produce any energy. To face this situation, the solar panel controller maintains the occurrence of the reversed current that may destroy the solar panel. In the solar panel controller is also facilitated with the connection to the load directly. Although there is load connected to the solar panel controller, the three previous functions stills work.

5. CONCLUSION

In line with the idea presented by Ferry and Monoian (2012) curriculum is an educational response to needs of the society and the state to prepare its generation. Indonesia certainly should also prepare its curriculum on the condition as a tropical country. As McNeil (2006) puts it, curriculum is an educational design to develop the students' potency to improve the quality of their society and nation. The 2013 curriculum has been designed in accordance with the idea presented by McNeil pedagogically but it is necessary to add a specific matter namely the attitudes towards the use of the sunlight.

The big countries have stated that the renewable energy technology is a program in the academic world to raise some awareness of the importance of energy and to encourage positive attitudes that in the long run the energy fossil will run out. The 2013 curriculum needs a legal power to include the material into it. Moreover, it is also necessary to formulize the competence on the renewable energy (especially solar panel energy) explicitly into one of or some subject matters at school. It is in line with the suggestion given by Cholily *et al.* (2017) in the Guideline of the Implementation of the Renewable Energy Curriculum.

There are some factors that have not support and even may become the hindrances to introduce the learning of solar panel to the students in Junior High School. These were presented by the teachers in during the Forum Discussion process: a) there was no basic competence that contain energy, solar panel in all subject matters; b) the teachers did not have any authority to add the competence although it is good; c) the teachers did not have enough competence on solar panel and d) no legal formal power was possessed to teach solar panel energy.

Moreover, there are some supporting factors that enable the learning of the solar panel to be conducted at Junior High School. The supports may be in the forms of the natural condition the technology development, or the opportunities to do some learning of the subject in the classroom. The main factor is the natural support since

Indonesia is located in the tropical area. The intensity of the sunlight is stable each day. The technology development is also a supporting factor since the components of the solar panel controllers are easy to find. The third supporting factor is the opportunities to include the materials of the solar panel energy into the subject matter of craft. It is clearly written in the Teacher's Book that the field of craft may be conducted in four aspects: a) craft; b) engineering; c) cultivation, and d) processing (Kemendikbud, 2014).

Based on the descriptions above, it can be stated that the learning of electric energy using the solar cell provides the students with the ability to understand solar energy, how the sunlight is conversed into the electric energy. Then, through the inquiry approach the students assemble the solar cell to produce electricity. At the last stage, the students are able to store the electricity from the solar energy into batteries and are able to use it in the daily life.

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