JPII 8 (4) (2019) 521-528

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

THE EFFECTIVENESS OF EDUCATION FOR ENVIRONMENTAL SUSTAINABLE DEVELOPMENT TO ENHANCE ENVIRONMENTAL LITERACY IN SCIENCE EDUCATION: A CASE STUDY OF HYDROPOWER

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DOI: 10.15294/jpii.v8i4.19948

Accepted: August 19th, 2019. Approved: December 27th, 2019. Published: December 31st, 2019

ABSTRACT

Renewable energy sources in Indonesia, such as hydropower, are very abundant. However, the utilization of these sources as alternative energy in Indonesia has not been optimized. Education for Environmental Sustainable Development (EESD) approach could be implemented in science education to give students valuable insights into the environment. The form of teaching materials for EESD is the student worksheet. The objective of this study was to analyze the effectiveness of learning using EESD-based student worksheets to improve environmental literacy. This study belonged to the quasi-experiment, and the sample was taken using a cluster sampling technique class. The findings of this research showed that the mean score of the experimental class was greater than the control class, and there was a remarkable difference in environmental literacy between the experimental and control class. Therefore, we could conclude that EESD-based student worksheets are useful to improve students' environmental literacy.

Keywords: education for environmental sustainable development, environmental literacy, environmental sustainable

INTRODUCTION

Energy is an increasingly basic human need. Energy demand growth is about 10% annually (OECD, 2012), where fossil energy sources, namely petroleum, coal, and natural gas, are still dominant. Since these fossil energies are non-renewable energy sources, their availability will eventually be depleted and exhausted. As a natural resource, energy should be used as wise as possible for the sake of people's welfare, and its management should refer to the principle of sustainable development (Mujiyanto & Tiess, 2013).

Indonesia is a country that has abundant wealth of renewable energy sources, namely geothermal (Pan et al., 2019), hydropower (Tang et al., 2019), wind (Pambudi & Nanankul, 2019), biogas (Khalil et al., 2019), solar

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(Soonmin et al., 2019), and ocean (Daryono et al., 2019), which can be utilized as an alternative energy. The utilization of these alternative energy resources will reduce dependence upon fossil fuels that are decreasing. Moreover, the potential for renewable energy is enormous, but it has only been utilized around 6% (Arinaldo et al., 2018; Hutapea, 2016).

The Ministry of Energy and Mineral Resources revealed that Indonesia's oil source is only enough for about 12 years (Surono, 2019). If no action is taken, then Indonesia will experience a crisis of oil resources. Hence, it is very urgent to promote the utilization of renewable energy sources and one of which is hydropower. Water is a potential source of renewable energy used as an alternative energy source as most of the regions in Indonesia are an archipelago united by water. Besides, water is also an environmentally friendly energy source.

It becomes a challenge for our generation to manage the environment to preserve the environment properly. An excellent environmental management could guarantee the availability of natural resources. One of the efforts to overcome the environmental crisis is through Education. Here, academics, experts, and administrators should handle environmental literacy promotion issues and sustainable development education in a more severe manner (Özgürler & Cansaran, 2014). By learning science, students are expected to experience a positive attitude change and later be able to contribute a positive impact on the environment. Srbinovski et al. (2010) stated that Environmental Education is not a discrete subject but incorporated in the Science Education curriculum.

Students need to be given provisions and excellent insights about the environment. Students should be instilled with a sensitive attitude towards the environment so that they are able to pay attention to current environmental conditions and think about maintaining the sustainability of the functional environmental carrying capacity. The improvement of the environmental literacy of students is needed. Environmental literacy is the skill of every individual to behave well in his or her daily life employing the understanding on the environmental conditions. Environmental literacy provides knowledge, and students may use the knowledge to make informed decisions about environmental issues (Hollweg et al., 2011). The increase of environmental literacy means preparing people who understand and can solve environmental problems so that environmental agents who have a caring attitude towards the environment can be prepared.

According to Coyle (2005), environmental literacy is one's ability to comprehend and interpret healthy environmental systems and to take any action to improve and preserve the system. Environmental Literacy Task Force (2015) defined environmental literacy as an ability to act individually and with others to support healthy, prosperous, and equitable ecology for present and future generations (ELTF, 2015). McBeth & Volk (2009) stated that the indicators of environmental literacy include ecological knowledge, real commitment (pro-environmental behavior), verbal commitment (intention to act), general environmental feelings, identification, environmental sensitivity, action planning, and analysis skills.

Karimzadegan & Meiboudi (2012) divided the domain of environmental literacy into four components: knowledge, skill, affective, and action. The domain of environmental literacy, according to Hollweg et al. (2011), includes knowledge, disposition, context, competencies, and environmentally responsible behavior. According to Srbinovski et al. (2010), all components of environmental literacy do not get the equal attention in every country. Several aspects dominate other aspects (Srbinovski et al., 2010). In this study, we conducted research on the component of affective or disposition. According to Danis (2013), the dimension of disposition is on the response to environmental problems, including the aspects of interest, sensitivity, responsibility, locus of control, and intention to act. This study has taken the dimension of disposition or affective on the aspects of environmental sensitivity, verbal commitment-intention to act, and personal responsibility.

Environmental sustainable development is able to overcome various environmental problems. The issue of sustainable environmental development is increasingly important to be realized through Education as it is one of the critical factors in attaining sustainable development. The education for sustainable environmental development (EESD) approach is suitably implemented in science learning to improve the students' environmental literacy. As conveyed by Locke et al. (2013) and Nasibulina (2015), environmental literacy principles are used to promote sustainable development. The EESD is a part of education for sustainable development on the environmental dimension.

Education for Sustainable Development (ESD) is a lifelong and vast attempt that confronts every individual, organization, and com-

munity to see tomorrow as a day for all of us, or it will not belong to anybody (Suprastowo et al., 2009; UNESCO, 2012). Tripon (2014) argued that ESD is a new paradigm in the field of Education that gives awareness and ability to all the leading people of the young generation to contribute significantly to sustainable development. Moreover, Gadotti (2010) stated that the sustainability concept is an outstanding element of education as environmental preservation relies on ecological awareness, which relies on the educational process. UNESCO (2012) said that the sustainability perspective constitutes social, economic, cultural, and environmental problems. The EESD is a concept of education for sustainable development which points to various environmental dimensions. The EESD is an effort to change attitudes and lifestyles through the awareness of natural resources, sensitive physical environment, the effect of human activities, and decision-making connected to environmental sustainability in the future.

Although there is an urgent need to motivate the utilization of renewable energy sources as argued above, improvement on the education system supporting renewable energy teaching and learning is required (Alexandar & Poyyamoli, 2014; Pedretti, 2014). The implementation of ESD-based learning methods in schools at any level is still developing with different discourses and practices (Eilks, 2015; Gilmanshina et al., 2018; Pedretti, 2014). Moreover, there is still a lack of awareness among students, teachers, and also the government of how important it is in promoting renewable energy (Leal Filho et al., 2019). In providing a better future free of fossil fuel dependence, the effort must start by the education of young generations, so that they realize that actions have to be taken in order to prevent, combat, or survive energy and environmental crisis that may arise in the future (Grossman, 2019). To address these crucial environmental issues, EESD is one of the appropriate approaches to be used, especially in Science Education. Hence, the intention of this study was to analyze the effectiveness of learning using EESD-based student worksheets to improve environmental literacy.

METHODS

This study is categorized as quasi-experiment research. As mentioned above, the objective of this study was to investigate the effectiveness of the EESD approach in improving students' environmental literacy. EESD approach was trained to students with the help of a science student worksheet that was best used to convey the approach for making it easier for students to comprehend the presented materials. A student worksheet is a practical, useful, and economic resource for use in learning activities (Kaymakcı, 2012). Misbah et al. (2018) disclosed that student worksheet is one of the essential teaching materials for attaining success in learning. The EESD-based science student worksheet used in the previous science learning process has been validated by the experts and belonged to the excellent category. The worksheets trained students to learn actively and contextually. Here, the teacher acted as a facilitator, and the learning process was centered on the students. Environmental programs will be more effective when students lively participate in activities (Locke et al., 2013). The materials contained in the student worksheets were related to the student environment; thus, they found it easier to understand the topic and apply their knowledge into their everyday life.

The subjects of this study were 60 students from grade VII Pandak 1 Junior High School in the first semester of the 2017/2018 school year. Specifically, 30 students of grade VII C were included in the experimental class and 30 students of grade VII D belonged to the control class for the field-testing.

Field tests were conducted using the experimental design of the pre-test and post-test control group design model. Table 1 presents the research design of this study. In this field test, we took the samples of the two VII classes selected using the cluster sampling method, i.e., one class as the experimental class, and the other is the control class. The experimental class employed the EESD-based student worksheets for the learning process, while the control class used the conventional student worksheets. Science lesson on "Water as Alternative Energy Source" theme was carried out in three meetings with four activities. The topic for each activity can be seen in Table 2.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
EC	O_1	X	O_2
CC	O_3		O_4

(Note: EC= Experimental Class, CC= Control Class, O_1= Early ability of Experimental Class, O_2= Later ability of Experimental Class, O_3= Early ability of control class, O_4= Later ability of control class, X_1= Treatment for Experimental Class, X_2= Treatment for Control Class)

Table 2. Topics of Learning Activities on "Water as an Alternative Energy Source" Theme

Activity	Topic	Information
1st	The energy in Human Life	1st meeting
2nd	Potential Water as Alternative Energy Source	2nd meeting
3rd	Making a Simple Waterwheel	Assignment
4th	Does Water Dam Have Energy?	3rd meeting

The implementation of learning with the EESD approach was assessed using the observation sheet of learning implementation. Some aspects are contained in the observation sheet of the learning implementation following the characteristics of the EESD approach. The assessment aspects of the observation sheet are presented in Table 3.

Table 3. The Assessment Aspects of the Observation Sheet

Meeting	Aspects of Assessment	Amounts of Indicators
1st	Systems of Thinking	4
	Foresighted Thinking and Strategizing	6
	Collaborating	4
	Action-Orientation	1
2nd	System of Thinking	5
	Foresighted Thinking and Strategizing	5
	Collaborating	4
3rd	Action-Orientation	8

The observation sheet was completed by an observer who understood the rubric or assessment guide so that the observation sheet can be used correctly. The percentage of learning can be calculated using the following equation (1).

% implementation = (∑ accomplished learning aspects /∑ overall aspects) x 100%.

Then, the percentage of learning activity was converted into qualitative data referring to the criteria proposed by Widoyoko (2009).

Table 4. The Percentage and Category of Learning Implementation

No.	Percentage	Category
1.	$80 \leq X \leq 100$	Very Good
2.	$60 \leq X < 80$	Good
3.	$40 \leq X < 60$	Enough
4.	$20 \leq X < 40$	Poor
5.	$0 \leq X < 20$	Very Poor

(Source: Widoyoko, 2009)

The students' environmental literacy on the attitude dimension in both experimental and control classes was measured at the learning process using the observation sheet. Observation on the environmental literacy was done by observers who have received previous training. Each group of students was observed by one observer. The dimensions of environmental literacy attitudes observed can be spotted in Table 5. The attitudes were assessed in four-grade scale. The observers were given a scoring rubric used as a basis in providing environmental literacy scores. The average environmental literacy score of the three meetings in the experimental class was then compared with the control class to determine the effectiveness of the EESD approach in improving the students' environmental literacy.

Table 5. The Dimensions of Environmental Literacy Attitudes

The Dimensions of Environmental Literacy Attitudes	Indicator
Verbal Commitment-Intention to Act	Dare to express their opinions or ideas
	Dare to speak in front of the class
	Providing feedback when another friend expresses his or her opinion.
	Conveying opinions in group discussions related to energy issues.
	Asking question
	Drawing the conclusions from the core activities undertaken
Environmental Sensitivity	Keeping the environment clean
	Efficient in using energy, such as water and electricity
Personal Responsibility	Taking part in group activities
	Independent (not cheating) while doing individual tasks
	Submitting the tasks on time
	Paying attention to teacher explanations

The data were analyzed the effectiveness of the EESD approach to science learning to improve the students' environmental literacy. The effectiveness analysis was done by comparing the average value of environmental literacy between the experimental and the control class. There was a remarkable difference in the average of environmental literacy between the experimental and the control class if the independent sample t-test satisfies sig.2-tailed < 0.05. The hypothesis of this study is presented as follows.

H_0: There is no notable difference in students' environmental literacy scores between experimental and control class.

H_1: There is a notable difference in students' environmental literacy scores between the experimental and the control class.

RESULTS AND DISCUSSION

The effectiveness of the EESD-based student worksheets was obtained from the implementation of science learning using the EESD approach and from the statistical test of the students' environmental literacy results. The implementation of learning was known based on the percentage of learning activities that can be observed in Table 6. The percentage of EESD approach implementation illustrates the level of success of the EESD approach applied in science learning.

The EESD Competencies by Frisk & Larson (2011) and Redman (2013) included (1) systems of thinking and comprehension of interconnectedness; (2) long-term and foresighted thinking; (3) stakeholder engagement and group collaboration; and (4) action-orientation and change-agent skills. Moreover, the EESD competencies in this research include system thinking, collaborating, foresighted thinking and strategizing, and action-orientation.

The data in Table 6 shows that the percentage of learning activity with the EESD approach by teachers and students was above 80%. If converted following Table 4, these results were included in an outstanding category. This shows that the EESD approach can be implemented very well in science learning.

Table 6. The Percentage of Learning Implementation with EESD Approach

Subject	Implementation (%)
Teacher	100
Student	95

The students' environmental literacy data were obtained based on the observers' assessment. The assessment aspect of the students' environmental literacy on the attitude domain can be seen in the following Table 7.

Table 7. The Assessment Aspects of the Students' Environmental Literacy on the Attitude Domain

The aspect of Environmental Literacy	Number of Items
Verbal Commitment-Intention to Act	6
Environmental Sensitivity	2
Personal Responsibility	4

Table 7 informs that the number of assessment indicators for each environmental literacy aspect is not the same. The verbal commitment-intention to act, environmental sensitivity, and personal responsibility aspects consist of six, two, and four items of assessment indicators, respectively. The verbal commitment-intention to act has a more significant number of assessment indicators than other aspects because it is more easily seen and observed on the students in the learning process. Moreover, the analysis of environmental literacy data was conducted using the independent sample t-test to find out whether there were notable differences in students' environmental literacy between the experimental and the control classes. The student environmental literacy data can be seen in Table 8.

Table 8. The Score of Students Environmental Literacy

	Experimental Class	Control Class
The number of students	30.00	30.00
Highest Score	88.00	70.00
Lowest Score	63.00	38.00
Average	76.90	46.87

Table 8 shows that the average environmental literacy of the experimental class was higher than the control class, i.e., 76.90% compared to 46.87%. The highest score of environmental literacy was also found in the experimental class (88%), while the lowest score was obtained in the control class (38%).

Figure 1 conveys that the environmental literacy score of the experimental class was higher than the control class. The average score of the environmental literacy of each student in three meetings in the experimental and control classes was analyzed using an independent sample t-test at a significance level of 5%. Prior to an analysis by an independent sample t-test, some prerequisite tests were performed employing the normality and homogeneity tests. The normality test was in-

tended to determine whether the data from each variable was normally distributed or not. The requirement for normally distributed data was probability (Sig.) > 0.05 (Triton, 2006).

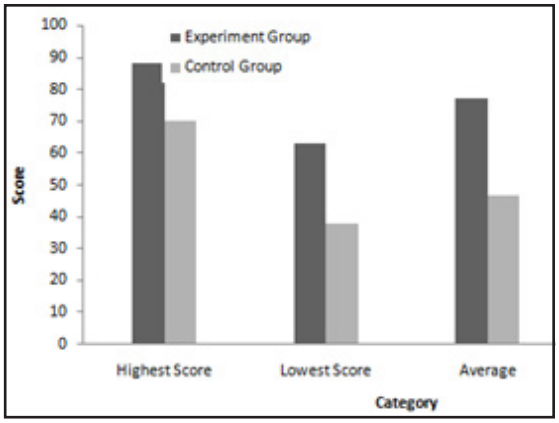

Figure 1. The Score of Students' Environmental Literacy

Moreover, the homogeneity test aimed to know whether the sample came from a homogeneous population or not by comparing the two variances. The data requirement derived from the homogeneous population was probability (Sig.) > 0.05, and if the probability of (Sig.) < 0.05, then the data were not homogeneous. The prerequisite test results could be seen in Table 9.

Table 9. The Test Prerequisite Hypothesis

Prerequisite Test	Significance Value
Normality test	Experiment class: 0.200 Control class: 0.053
Homogeneity test	0.617

Table 9 shows that the results of the normality test on environmental literacy data of the control and the experimental class was higher than 0.05, indicating that the students' environmental literacy ability was normally distributed. The homogeneity test resulted in the students' environmental literacy data also showed a value higher than 0.05, indicating that the data came from a homogeneous population. Because the data have met the hypothesis prerequisite test, it could be tested with a hypothesis examined using an independent sample t-test. The results of the independent sample t-test can be seen in Table 10.

Table 10. The Independent T-test Sample

Variable	Sig.(2-tailed)
Environmental Literacy	0.000

Table 10 shows that the sig.2-tailed value was 0.000 < 0.05. Hence, the H_0 was rejected, or there was a significant difference in environmental literacy between the experimental and the control class.

The EESD approach is a revolution in Education to change our views, knowledge, and attitude towards the environment. This study shows that student worksheet based on EESD is proven to increase environmental literacy, especially in the Energy topic.

The ESD framework with the teaching of science has a great potential to help students to develop their educational skills (Alexandar & Poyyamoli, 2014). Sustainable education is highly appropriate the professions involved in the environmental fields, as it plays a vital role in reducing the consumption of natural resources and in shaping the character of individuals within their communities and the natural environment (Eilks, 2015). The EESD appears as an essential approach to encourage the students to conserve and protect the natural resources in their environment (Juntunen & Aksela, 2013).

Future citizens must have the skills to act sustainably according to their expertise (Holdsworth & Sandri, 2015). In the world of education, a teacher can play a role in environmental sustainability by fostering the students' views on environmental issues around them. Contextual science learning will make students have a higher environmental stance. The young generation who have the right attitude of environmental literacy will concern the sustainability of the environment and it is hoped to significantly help the world in the future, in terms of natural resources security.

CONCLUSIONS

In this study, we have presented the learning implementation using the EESD approach. Competencies of EESD applied in the learning process are systems of thinking, action-orientation, foresighted thinking and strategizing, and collaborating. The results showed that the EESD approach can be applied in the science learning process. The EESD approach is an innovation in the field of education to prepare a young generation that is concerned with the environment. The results also indicated that the application of the EESD approach in science learning increased the students' environmental literacy of the experimental class compared to that of the control class as the sign on the independent sample t-test was 0.000 < 0.05. This means that there was a notable difference in environmental literacy between the experimental and control class. The EESD approach has accommodated the students in deve-

loping their environmental literacy attitudes. The findings of this study are useful for teachers to use EESD-based student worksheets to improve the students' environmental literacy. Moreover, teachers can modify this science student worksheets according to the condition of students and the environment.

ACKNOWLEDGEMENTS

Sincere thanks goes to the Postgraduate Program of Science Education, Universitas Negeri Yogyakarta for the support in producing this work.

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