

Effectiveness of Education for Environmental Sustainable Development to Enhance Environmental Literacy

Anita Ekantini^{1, a)} and Insih Wilujeng^{1, b)}

¹*Department of Science Education Postgraduate Program, Yogyakarta State University, Yogyakarta, 55281, Indonesia*

^{a)}Corresponding author: anitaekantini@gmail.com
^{b)}insihuny@yahoo.co.id

Abstract. The renewable energy sources in Indonesia are very abundant, for example hydropower. However, the utilization of these sources as an alternative energy in Indonesia has not been maximized. Education for Environmental Sustainable Development (EESD) approach can be applied in science education to give learners supplies and good insight about environment. The teaching material for EESD is student worksheet. The purpose of this study is to analyze the effectiveness of learning using EESD-based student worksheets to improve environmental literacy. This study is a quasi-experiment and the sample has been taken using cluster sampling technique class. The findings of this research were mean score of the experimental class environmental literacy was higher than control class and there was significant difference of environmental literacy between the experimental and control class. We can conclude that EESD-based student worksheets are effective to improve students' environmental literacy.

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

INTRODUCTION

Energy is an increasingly basic human need. Energy demand growth is about 10% annually [1]. Fossil energy sources, namely petroleum, coal, and natural gas are still dominant [2]. Since the fossil energy is non renewable energy source, its availability will eventually be depleted and exhausted. As a natural resource, energy should be utilized as much as possible for the people welfare and its management should refer to the principle of sustainable development [3].

Indonesia is a country that has the abundant wealth of renewable energy sources, namely geothermal, hydropower, wind energy, biogas, solar energy, marine energy, which can be utilized as an alternative energy. The utilization of this alternative energy source will reduce dependence on fossil fuels that are depleting its reserves. The potential for renewable energy is enormous, but it has only been utilized around 6% [4].

The Minister of Energy and Mineral Resources, Sudirman Said, revealed that Indonesia's oil source is only enough for about 12 years [5]. If not taking an action, then Indonesia will experience a crisis of oil resources. It is very urgent to promote the movement of utilization of renewable energy sources, 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 the archipelago united by waters. In addition, water is also an environmentally friendly energy source.

It become a challenge for our generation to manage the environment to preserve the environment as well as possible. A good environmental management can guarantee the availability of natural resources. One of the efforts to overcome the environmental crisis is through education. Here, environmental literacy promotion issues and sustainable development education should be handled by academics, experts, and administrators in a more serious

manner [6]. By learning science, learners are expected to experience a positive attitude change; later also able to contribute a positive impact on the environment. Srbinovski et al. (2010) states that environmental education is not in a separate subject, but incorporated in the science education curriculum [7].

Learners need to be given provisions and good insight about the environment. The 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 to maintain the sustainability of the good environmental carrying capacity. The improvement of environmental literacy ability of learners is needed. Environmental literacy is the ability of every individual to behave well in his or her daily life by means of the understanding of environmental conditions. Environmental literacy provides knowledge to use knowledge to make informed decisions about environmental issues [8]. The increase of environmental literacy means to prepare human beings who understand and can solve environmental problems, so environmental agents who have a care attitude towards the environment can be prepared.

According to Coyle (2005) environmental literacy is the ability to understand and interpret the health of environmental systems and to take an action to improve and maintain the system [9]. Environmental Literacy Task Force (2015) defines environmental literacy as an ability to act individually and with others to support healthy, prosperous, and equitable ecology for present and future generations [10]. McBeth (2010) stated that the indicators of environmental literacy include ecological knowledge, verbal commitment (Intention to Act), actual commitment (Pro-Environmental Behavior), environmental sensitivity, general environmental feelings, issue identification, issue analysis skills, and action planning [11].

Karimzadegan (2012) divided the domain of environmental literacy into 4 components: knowledge, skill, affective, and action [12]. The domain of environmental literacy according to Hollweg (2011) includes knowledge, disposition, competencies, context, and environmentally responsible behaviour [8]. According to Srbinovski et al. (2010) all components of environmental literacy do not get the same attention in every country. There are several aspects that dominate from other aspects [7]. In this study, researchers conducted a research on the component affective/disposition. According to Danis (2013) dimension disposition is on how the response to environmental problems, including the aspects of interest, sensitivity, locus of control, responsibility, and intention to act. This study has taken the dimension of disposition/affective on the aspects of Verbal Commitment-Intention to Act, Environmental Sensitivity, and personal responsibility [13].

Environmental sustainable development is able to overcome various environmental problems. The issue of sustainable environmental development is increasingly important to be realized through education. Education is one of the key factors in achieving sustainable development [14]. The education for environmental sustainable development (EESD) approach is appropriately applied in science learning to improve the students' environmental literacy. As conveyed by Locke et al. (2013), environmental literacy principles are used to promote the sustainable development [15]. EESD is a part of education for sustainable development on the environmental dimension.

Education for Sustainable Development (ESD) is a vast and lifelong effort that challenges every individual, institution and community to view tomorrow as a day for all of us, or it will not belong to anybody [16]. Hastuti (2009) argued that ESD is a new paradigm in the field of education that gives an awareness and ability to all the main people of the young generation to contribute significantly to sustainable development [17]. Gadotti (2010: 205) stated that the concept of sustainability is an excellent component of education because environmental preservation depends on ecological awareness, which depends on the educational process [18]. UNESCO (2012) stated that sustainability perspective represents the economic, social, cultural and environmental problems [19].

Education for Environmental Sustainable Development is a concept of Education for Sustainable Development focused on environmental dimensions. Education for Environmental Sustainable Development is an effort to change attitudes and lifestyles through the awareness of natural resources, sensitive physical environment, the impact of human activities, and decision-making related to environmental sustainability in the future.

METHODS

Type of the Research Method

This research was quasi experiment. The purpose of this study was to examine the effectiveness of the EESD approach in improving students' environmental literacy. EESD approach was trained to students with the help of science student worksheet that was best used to convey the EESD approach for making it easier for students to understand the material presented. Student worksheet is a practical, useful and economical resource for use in

learning activities [20]. Damayanti (2013) disclosed that student worksheet is one of the most important teaching materials for achieving success in learning [21]. The EESD-based science student worksheet used in the previous science learning process has been validated by the experts and the category of a very good scored. Student worksheet based on EESD trained students to learn actively and contextually. The teacher here acted as a facilitator, so the learning process was centered on the students. Environmental programs will be more effective when students actively participate in activities [15]. The material contained in the student worksheet was related to the student environment; thus, the students found it easier to understand the energy materials and apply their knowledge in their life.

Subject of the Research

The subjects of this research were 60 students from grade VII Pandak 1 Junior High Scholl in the first semester of 2017/2018 school year. The subjects are consisting of 30 students of VII C as experimental class and 30 students of VII D as control class for main field testing.

Experimental Procedure

Field tests were conducted using the experimental design of the Pre-test and Post-test Control Group Design model. **TABLE 1.** present the research design. In this field test, researchers took the samples of the two classes of class VII selected using the cluster sampling method, one class as the experimental class and another as the control class. The experimental class used the EESD-based student worksheet on the learning process, while the control class used the conventional student worksheet. Science Lesson with the theme "Water as Alternative Energy Source" conducted in three meetings with four activities. The topics 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

O1= Early ability of Experimental Class

O2= Later ability of Experimental Class

O3= Early ability of control class

O4= Later ability of control class

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

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

The implementation of learning using EESD approach was assessed using the observation sheet of learning implementation. Some aspects contained in the observation sheet of the learning implementation in accordance with the characteristics of the EESD approach. The materials of the observation sheet of the learning implementation with the EESD approach can be seen in **TABLE 3.**

The filling of the observation sheet for the EESD approach was carried out by an observer who understood the rubric or assessment guide, so that they can use the observation sheet correctly. The percentage of learning can be calculated by the equation as follows.

$$\% \text{ implementation} = \frac{\Sigma \text{aspects of learning that are accomplished}}{\Sigma \text{overall aspect}} \times 100\% \quad (1)$$

The percentage of learning activity then was converted into the qualitative data by using criteria from Widoyoko [22].

TABLE 3. The Materials of the Observation Sheet of the Learning Implementation with the EESD Approach

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

TABLE 4. 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: [22])

The students' environmental literacy on attitude dimension in both experimental and control class was measured at the learning process using environmental literacy observation sheet. Observation on the attitude of environmental literacy was done by observers who have received a previous training. Each group of students was observed by one observer. The observers were on duty to observe the attitude of the environmental literacy of students and assessed them. The materials of observed environmental literacy attitudes can be seen in **TABLE 5**. The scale of assessment of environmental literacy attitudes used was the scale of four. The observers were given a scoring rubric used as a basis in providing environmental literacy scores to students. 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 EESD approach in improving the students' environmental literacy.

TABLE 5. Materials Environmental Literacy

Environmental Literacy Aspects of Attitude Dimensions	Indicator
Verbal Commitment-Intention to Act	Dare to express their opinions / ideas
	Dare to speak in front of the class
	Providing feedback when another friend expresses his or her opinion
	Contributing opinions in group discussions related to energy issues.
	Asking question
	Conveying 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 a part in group activities
	Independent (not cheating) while doing individual tasks

Submitting the tasks on time

Paying attention to teacher explanations

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

H₀: There is no any significant difference in the student's environmental literacy scores between experimental class and control classes

H₁: There is a significant difference in students environmental literacy score between the experimental class and the control class

RESULT AND DISCUSSIONS

The effectiveness of the EESD-based student worksheet was known from the implementation of learning using the EESD approach and from the statistical test of the students' environmental literacy results. The implementation of learning with EESD approach was known based on the percentage of learning activities that can be seen in **TABLE 6**. The assessment of the learning implementation using EESD approach was an assessment of the implementation of EESD approaches characteristics in the science lesson. The percentage of EESD approach implementation illustrated the level of success of the EESD approach applied in science learning.

EESD Competencies by Frisk & Larson (2011) include (1) systems thinking and an understanding of interconnectedness, (2) long-term, and foresighted thinking, (3) stakeholder engagement and group collaboration, (4) action-orientation and change-agent skills [23]. Redman stated that the competencies of sustainability include (1) system thinking and understanding of interconnectedness, (2) long-term, foresighted reasoning, and strategizing, (3) stakeholder's engagement and group collaboration, (4) action orientation and change-agent skills [24]. EESD competencies in this research included Systems Thinking, Foresighted Thinking and Strategizing, Collaborating, and Action-Orientation.

The data in **TABLE 6**. shows the percentage of learning activity with EESD approach by teachers and students above 80%. The results if converted in accordance with **TABLE 4** are included in very good category. This shows that EESD approach can be implemented very well in science learning.

TABLE 6. Percentage of Learning Implementation with EESD Approach

Subject	% Implementation
Teacher	100
Student	95

Student's environmental literacy data were obtained based on the observer's assessment of students' environmental literacy attitudes. The assessment aspect of the students' environmental literacy on the attitude domain can be seen in **TABLE 7**.

TABLE 7. The Assessment Aspect of the Students' Environmental Literacy on the Attitude Domain

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

TABLE 7. shows that the number of assessment indicator for each environmental literacy aspect is not the same. The verbal commitment-intention to act aspect consists of six points of assessment indicators. The environmental sensitivity aspect consists of two assessment indicators. The personal responsibility aspect consists of four items of assessment indicators. The verbal commitment-intention to act aspect has a greater number of assessment indicators than other aspects because this aspect is more easily visible and observable to students in the learning process.

The analysis of environmental literacy data was conducted using the independent sample t-test to find out whether there were significant differences in students' environmental literacy between the experimental class and the control class. 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 Scores	88.00	70.00
Lowest Scores	63.00	38.00
Average	76.90	46.87

TABLE 8. shows that the average environmental literacy of experimental class was higher than of the control class. The highest score of environmental literacy was also found in the experimental class, while the lowest score was in the control class.

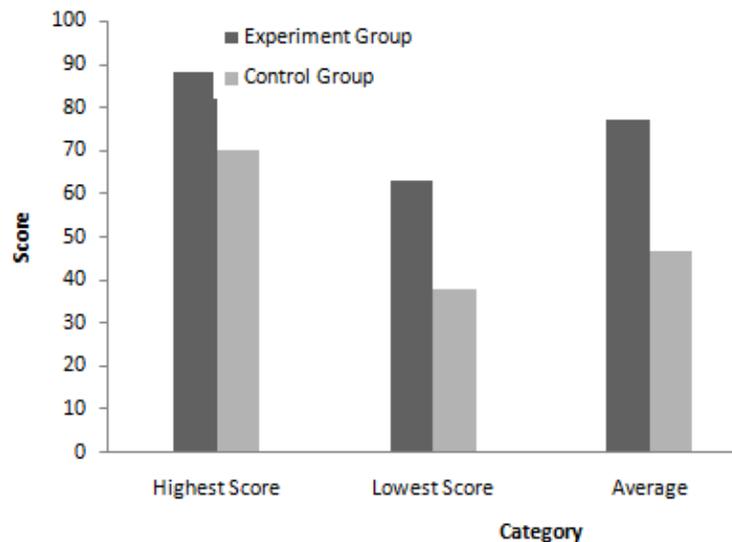


FIGURE 1. The score of Students Environmental Literacy

FIGURE 1. shows that the environmental literacy score of experimental class is higher than control class. The average of environmental literacy of each student in three meetings in the experimental class and control class was analyzed using an independent sample t-test at the significance level of 5%. Prior to analysis by independent sample t-test, some prerequisite tests were performed that included normality and homogeneity tests. Normality test was intended to determine whether the data from each variable was normally distributed or not. The requirement for normally distributed data was the probability or (Sig.) > 0.05 [25]. Homogeneity test aimed to know the sample 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 (Sig.) < 0.05 then the data was not homogeneous [25]. The prerequisite test results can be seen in **TABLE 9**.

TABLE 9. Test Prerequisite Hypothesis

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

TABLE 9. shows that the result of normality test on environmental literacy data of control class and experimental class was greater than 0.05, indicating that the students' environmental literacy ability was normally

distributed. Homogeneity test resulted in the students' environmental literacy data also showed that the value was greater than 0.05 indicating that the data came from a homogeneous population. Because the data has met the hypothesis prerequisite test, it could be tested with a hypothesis that is by test independent sample t-test. The results of the independent sample t-test can be seen in **TABLE 10**.

TABLE 10. Independent Sample T-Test

Variable	Sig.(2-tailed)
Environmental Literacy	0.000

TABLE 10. shows that the sig.2-tailed value was $0.000 < 0.05$. It can be stated that H_0 was rejected or there was a significant difference in environmental literacy between the experimental class and the control class.

EESD approach is a revolution in education to change our views, knowledge and attitude towards the environment. This research shows that student worksheet based on EESD is proven to increase environmental literacy, in this research especially in energy matter.

ESD framework with the teaching of science has a great potential to help the students to develop their educational skills [26]. Sustainable education is highly relevant to the professions involved in the built environment, as they play a role in reducing the consumption of natural resources and in shaping the character between individuals within their communities and the natural environment [27]. Environmental education for sustainable development is appearing as an important approach to encourage the students to conserve and protect the natural environment in their environment [28].

Future citizens must have the skills to act sustainably according to their own expertise [29]. In the world of education, a teacher can play a role in environmental sustainability by fostering students' views on environmental issues around them. Contextual science learning will make students have a higher environmental stance. The young generation who have a good attitude of environmental literacy, will have concern for the sustainability of the environment. This will greatly help the world in the future. Natural resources will remain sustainable and continue to be utilized forever.

CONCLUSION

In this article we have presented the learning implementation with EESD approach. Competencies of EESD applied in the learning process are systems thinking, foresighted thinking and strategizing, collaborating, and action-orientation. The result shows that EESD approach can be applied very well in science learning process. The EESD approach is an innovation in the field of education to prepare the young generation that has a concern with environmental concerns. Students are the young generation that will be an environmental agent to make their environment better. So it's a very urgent for EESD approach to be applied in learning. We also describe the effectiveness of EESD-based student worksheet. The results showed that the application of EESD approach in science teaching effectively can increase the students' environmental literacy with average of experimental class higher than that of control class and significance on the independent sample t test was $0.000 < 0.05$. This shows that there are significant differences in environmental literacy between the experimental class and control class. EESD approach accommodates students in developing their environmental literacy attitude. Based on the findings of this research, it is useful for teachers to use EESD-based student worksheet to improve student's environmental literacy. Teachers can modify this science student worksheet as the condition of the student and environment.

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