PAEDAGOGIA
Jurnal Penelitian Pendidikan,
http://jurnal.uns.ac.id/paedagogia

DOI: 10.20961/paedagogia.v24i1.54212
Hal.53-60
Vol. 24 No. 1,Februari Tahun 2021
p-ISSN 0126-4109; e-ISSN 2549-6670

STEM LEARNING IN SUSTAINABILITY ISSUES TO IMPROVE SUSTAINABILITY CONSCIOUSNESS OF JUNIOR HIGH SCHOOL STUDENTS

STEM Pembelajaran berbasis *Sustainability Issues* untuk Meningkatkan Kesadaran Keberlanjutan Siswa SMP

Rahmania Firda[1]*, Ida Kaniwati[2], Siti Sriyati[2]

[1]Science Education Study Program, Universitas Pendidikan Indonesia, Indonesia
[2] Graduate Program, Universitas Pendidikan Indonesia, Indonesia

Abstract: Sustainability consciousness is the expected result with the existence of ESD that is a complicated construction that can be influenced by various factors. ESD aims to develop students' understanding of sustainability issues and change students' attitudes and behavior regarding environmental, social, and economic sustainability. The purpose of this paper is to determine the improvement of students' sustainability consciousness after STEM learning in sustainability issues was implemented. This study used pre-experimental method with one group pretes-posttest design. The sample of this study consisted of 28 seventh grades students of junior high school in Surabaya. The sustainability consciousness profile is measured using a questionnaire containing 20 quizzes using three categories consisting of sustainable knowledge, sustainable attitudes, sustainable behavior regarding regarding environmental, social, and economic. The instrument was declared as valid based on expert's judgment and showed Alpha Cronbach score 0,85. Data was collected by pretest and posttest of sustainability consciousness questionnaire. Based on the data analysis, it showed that sustainability issues were effectively integrated into STEM learning to enhance the sustainability consciousness of junior high school students. N-gain average of sustainability consciousness were 0,18 as low category. The findings suggest that required learning strategies that can provide more opportunities for students to learn about sustainability issues and develop pro-sustainability attitudes and behaviors.

Keyword: sustainability consciousness, ESD, STEM, sustainability issues

Abstract: Kesadaran keberlanjutan adalah hasil yang diharapkan dengan adanya ESD yang merupakan konstruksi rumit yang dapat dipengaruhi oleh berbagai faktor. ESD bertujuan untuk mengembangkan pemahaman siswa tentang isu-isu keberlanjutan dan mengubah sikap dan perilaku siswa tentang keberlanjutan lingkungan, sosial, dan ekonomi. Tujuan dari makalah ini adalah untuk mengetahui peningkatan kesadaran keberlanjutan siswa setelah pembelajaran STEM dalam isu keberlanjutan diterapkan. Penelitian ini menggunakan metode pra-eksperimen dengan desain one group pretes-posttest design. Sampel penelitian ini terdiri dari 28 siswa kelas VII SMP di Surabaya. Profil kesadaran keberlanjutan diukur dengan menggunakan kuesioner yang berisi 20 kuis dengan menggunakan tiga kategori yang terdiri dari pengetahuan berkelanjutan, sikap berkelanjutan, perilaku berkelanjutan terkait lingkungan, sosial, dan ekonomi. Instrumen dinyatakan valid berdasarkan penilaian ahli dan menunjukkan skor Alpha Cronbach 0,85. Pengumpulan data dilakukan dengan pretest dan posttest kuesioner kesadaran keberlanjutan.

Alamat korespondensi: Jalan Dr. Setiabudhi No. 229, Bandung 40154, Indonesia
e-email: firda.rahmani4@upi.edu

Received: 26 April ,2021 Accepted: 18 July , 2021 Online Published: 29 July 2021

Berdasarkan analisis data, menunjukkan bahwa isu keberlanjutan secara efektif diintegrasikan ke dalam pembelajaran STEM untuk meningkatkan kesadaran keberlanjutan siswa sekolah menengah pertama. Rata-rata N-gain kesadaran keberlanjutan adalah 0,18 termasuk kategori rendah. Temuan menunjukkan bahwa diperlukan strategi pembelajaran yang dapat memberikan lebih banyak kesempatan bagi siswa untuk belajar tentang isu-isu keberlanjutan dan mengembangkan sikap dan perilaku pro-keberlanjutan.

Kata Kunci: kesadaran keberlanjutan , ESD, STEM, Sustainability Issues

INTODUCTION

In 2002, UNESCO officially introduced the concept of ESD in Johannesburg. Learning using the ESD context leads students to ask questions, learn to clarify one's values, learn to think sustainably, and learn to think (Tilbury, 2011). sustainability issues are wicked problems that must be addressed, ESD needs to empower students to be able to understand the problems holistically and take actions at individual and collective levels (Brundiers & Wiek, 2013). Therfore, the focus of ESD should be on developing students' understanding of sustainability issues and change students' attitudes and behavior regarding environmental, social, and economic sustainability (Kalsoom & Khanam, 2017)

Sustainability consciousness is the expected result with the existence of ESD that is a complicated construction that can be influenced by various factors. Such as research conducted by Kalsoom et al. (2017) regarding surveys to measure knowledge, attitude, and behavior towards sustainable development that reports SC of the preservice teachers in Pakistan is much lower than that of Swedish upper upper secondary students. The result of this study indicate that development of SC is not simply the ESD profile but the education culture as a whole (including environmental care, social justice, democracy, economic equity). Sustainability consciousness (SC) is one of umbrella term that used by a Swedish research group at Karlstad University to describe an individual's knowledge, attitudes, and behaviors in each of the three dimensions of sustainability: social, economic, and environmental. They reported SC of grade 6, 9 and 12 students studying in ESD-profiled and non-ESD profiled schools in Sweden (Berglund et al., 2014; Berglund and Gericke, 2016; Boeve-de-Pauw et al., 2015; Olsson et al., 2016; Olsson and Gericke, 2016).

The sustainability issue raised in this study is the pollution that occurs in mangrove forests. The material on environmental pollution consists of pollutant substances that can damage ecosystems, especially the water, air, and soil environments that surround human life. Students need to understand the theory of pollution and introduce pollution problems that occur in the surrounding environment. One of the rare ecosystems in the world with an area of only 2% of the earth's surface is the mangrove ecosystem. This ecosystem has decreased by 30-50% in the last half century due to pollution due to coastal development, expansion of pond development, and excessive logging (Cifor, 2012). According to Setyawan and Winarno (2016), mangrove forests are ecosystems that have ecological, socio-economic, and socio-cultural roles in accordance with the context of Education for Sustainable Development (ESD). With the introduction of environmental pollution material that occurs in the Mangrove Forest, it is hoped that students can use their knowledge to provide solutions to environmental pollution problems and have sustainable thinking so that the environment remains sustainable.

The application of science to overcome problems or issues that occur in everyday life aims to make the learning process in schools meaningful and direct students to have sustainable thinking. The problem-oriented transdisciplinary learning researched by Dlouha and Burandt (2015) is one of the learning methods by linking real-world issues that have an impact on the achievement of ESD competencies that indicate the learning environment provides opportunities for teachers to support interactive and independent learning. The paper aims to determine the improvement of students' sustainability consciousness after attending STEM learning in sustainability issues. The goal of STEM in sustainability issues is raising student's awareness of sustainability. The results of this study are expected to be used as a reference for other researchers to explore more deeply about learning strategies that can provide more opportunities for students to learn about sustainability issues and also develop attitudes and behaviors that are pro-sustainability.

RESEARCH METHOD

This study was done by quasi experimental method with with one group pretes-posttest design. The treatment of the class was done by conducting STEM learning in sustainability issues. Data was

collected by pretest and posttest of sustainability consciousness questionnaire. Table of design this study can be seen in Table 1.

Table 1. One Group Pretest-Posttest Design

O_1	X	O_2
Pretest	STEM learning in sustainability issues	*Posttest*

Based on the Table 1, questionnaire given in pretest and posttest are same. Data of the students were analysed to know the improvement of student's sustainability consciousness. Participants of this study were 28 seventh grades students of junior high school at Surabaya in academic year 2021/2022. Instruments used in this study were sustainability consciousness questionnaire which consist of 20 items to measure understanding of sustainability issues students' attitudes and behavior regarding environmental, social, and economic sustainability. The type of instrument used in this study is a Likert-scale questionnaire. This questionnaire uses five options including: extremely agree, agree, uncertain, disagree, and extremely disagree. The research flowchart in this study is divided into three stages including: preparation, implementation, and final stages. the research flow is explained systematically in Figure 1.

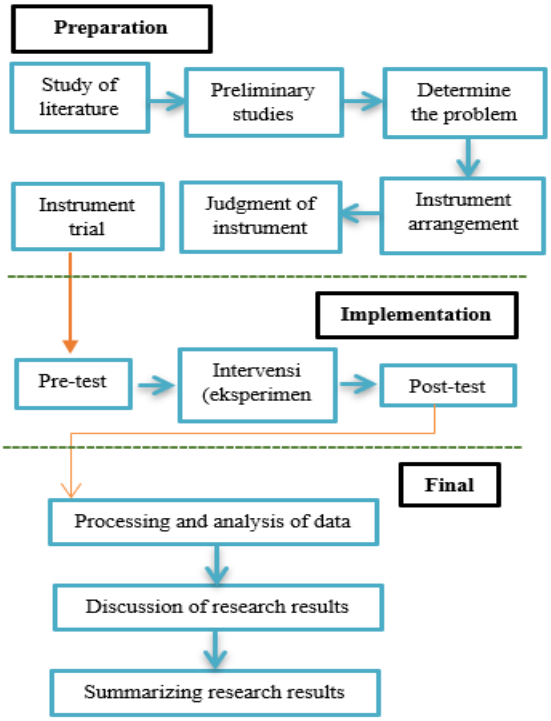

Figure 1. Research Flowchart

The questionnaire was consulted and validated by expert's judgment then tested. There were 20 items of test for understanding of sustainability issues students' attitudes and behavior regarding environmental, social, and economic sustainability and showed Alpha Cronbach score 0,85 (high category). Pretest-posttest of student's sustainability consciousness after STEM learning in sustainability issues is analyzed by calculating normalized (N-gain) average score. The formula used as follow:

$$\langle g \rangle = \frac{\%(S_f) - \%(S_i)}{100 - \%(S_f)}$$ (Hake, 1998)

Description:

<g> : Normalized gain

S_f : Average of posttest score

S_i : Average of pretest score

Interpretation of average normalized gain can be seen in Table 2:

Table 2. Category of Average Normalized Gain

Score <g>	Criteria
g ≥ 0,7	High
0,3 ≤ g < 0,7	Medium
g < 0,3	Low

RESULTS AND DISCUSSION

The purpose of this study was to determine the improvement of students' understanding of sustainability issues and change students' attitudes and behavior regarding environmental, social, and economic sustainability after STEM learning in sustainability issues was implemented. The pretest-posttest result of student's sustainability consciousness are presented in Figure 2.

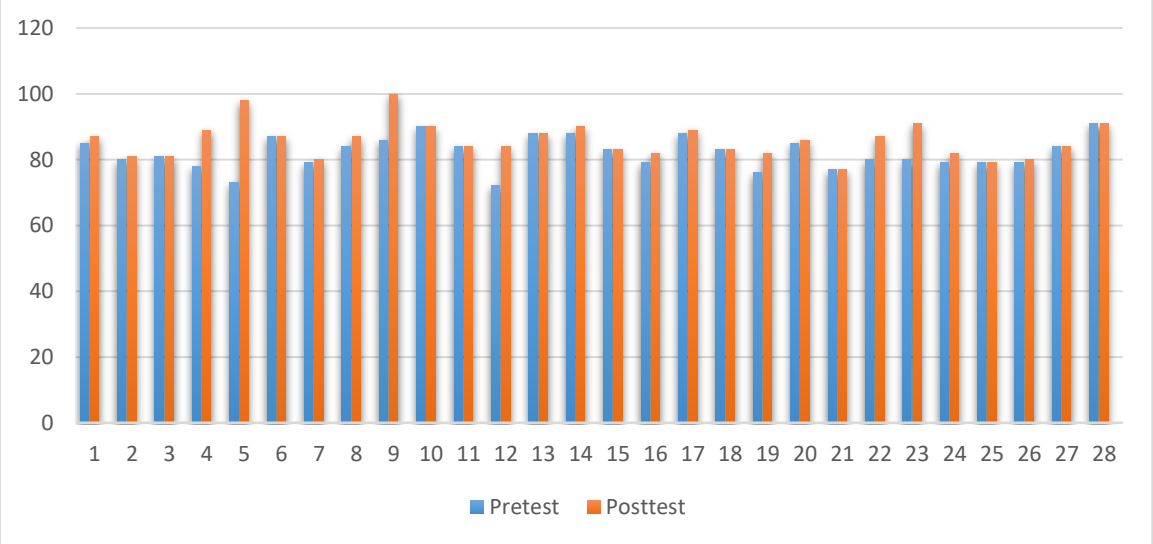

Figure 2. Improvement of Student's *Sustainability Consciousness*

Based on Figure 1, it showed an enhancement in pretest-posttets scores for sustainability consciousness profile of students. The average pretest score 82,07 incresed to 85,78 in posttest score. The higest pretest score obtained was 91 in very good category and the smallest pretest score but still in quite good category was 72. While the higest posttest score obtained was 100 in very good category and the smallest posttest score but still in good category was 77. N-gain was calculated from the result of student's pretest

and posttest scores after attending on STEM learning on sustainability issues. Meanwhile, the achievement of the sustainability consciousness profile in each category can be seen Figure 3.

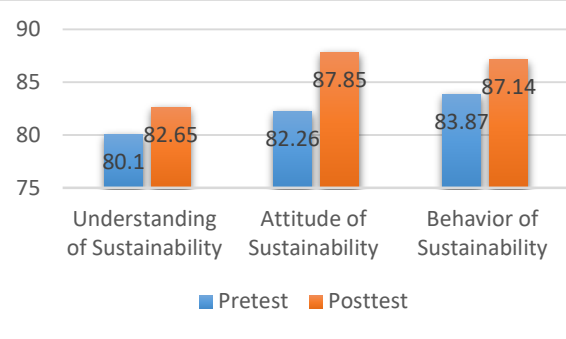

Figure 3. Percentage of Pretest-Posttest Scores for Each Category

Based on Figure 2, the average percentage in each category has increased. From the average pretest-posttest scores, N-gain was calculated to see the improvement in each category. The recapitulation of N-gain result for each category of sustainability consciousness profile can be seen in Table 3.

Based on the result of N-gain in each category on sustainability consciousness, percentage of students' understanding about sustainability issues got the lowest scores but still in good criteria in pretest-posttest 80,10% and 82,65%, respectively. N-gain for student's understanding of sustainability issues got the lowest result from other categories; 0,12 in low criteria. Meanwhile, the highest percentage was obtained by behavior category in pretest 83,87% and the highest percentage was obtained by attitude category in posttest 87,85%. The highest N-gain was also obtained by attitude category 0.31 in moderate criteria. Meanwhile, the overall N-gain average showed 0.18 in low category.

Table 3. N-gain of Sustainability Consciousness for Each Category

Table 3. N-gain of Sustainability Consciousness for Each Category

Treatment	Kategori Profil *Sustainability Consciousness*		
	Understanding of sustainability	Attitude of sustainability	Behavior of sustainability
Pretest	80,10	82,26	83,87
Posttest	82,65	87,85	87,14
N-gain	0,12	0,31	0,20
Criteria of N-gain	Low	Medium	Low

Based on the result of sustainability consciousness test, category of student's understanding about sustainability issues got the smallest pretest and posttest scores that compared to other categories but still in good criteria. N-gain of student's undertanding also got the smallest results with low criteria. Meanwhile, N-gain for attitudes of sustainability got the highest results from other categories 0.3 in medium category. The implementation of STEM learning in sustainability issues can provide changes to the student's sustainability consciousness profile with the result of an increase in the sustainability consciousness profile 0.18 in low cate-

gory. However, this learning is not optimal in developing students' understanding of sustainability issues. It was caused that sustainability development was new for students in learning. Students are directed to recognize several sustainability issues that lead them to change attitudes and behavior towards sustainability regarding environmental, social, and economic sustainability on STEM learning in sustainability issues. ESD is a transformative education that aims to develop students' understanding of sustainability issues and change students' attitudes and behavior regarding environmental, social, and economic sustainability. (Kalsoom & Khanam, 2017) [3]. SC is the expected result with the presence of ESD where SC is a complex construction and various factors can contribute to its development. According to Kalsoom et al. (2017) states that the development of SC is not due to the ESD profile, but the education culture as a whole (including environmental care, social justice, democracy, economic equity). The hope with STEM learning in the context of ESD is to make students more aware of sustainability. From the results of the study presented, the researcher suggests conducting more in-depth research on learning strategies that can provide more opportunities for students to learn about sustainability issues and also develop attitudes and behaviors that are pro-sustainability.

CONCLUSION

The conclusion of this study is enhancement of students' sustainability consciousness in Surabaya shows 0.18 in low category. While the enhancement of students' sustainability consciousness for each catagorie as follows: N-gain for student's understanding of sustainability issues got the lowest result from other categories; 0,12 in low criteria, N-gain for Behavior of sustainability got the result: 0,20 in low criteria, and N-gain for attitudes of sustainability got the highest results from other categories 0.3 in medium category. The results of this study showed implementation of STEM learning in sustainability issues can provide changes to the student's sustainability consciousness profile with the result of an increase in the sustainability consciousness profile 0.18 in low category. However, this learning is not optimal in developing students' understanding of sustainability issues. It was caused that sustainability development was new for students in learning.

REFERENCES

Berglund, T., Gericke, N., 2016. Separated and integrated perspectives on environmental, economic, and social dimensions–an investigation of student views on sustainable development. Environmental Education Research, 22(8), 1115-1138.

Berglund, T., Gericke, N., Chang Rundgren, S., 2014. The implementation of education for sustainable development in Sweden: investigating the sustainability consciousness among upper secondary students. Research in Science & Technological Education, 32(3), 318-339.

Boeve-de-Pauw, J., Gericke, N., Olsson, D., Berglund, T., 2015. The effectiveness of education for sustainable development. Sustainability, 7(11), 15693-15717.

Brundiers, K., and Wiek, A. (2013), "Do We Teach What We Preach? An International Comparison of Problem and Project-Based Learning Courses in Sustainability", Sustainability, Vol. 5 No. 4, pp.1725-1746.

CIFOR. (2012). Mangrove adalah salah satu hutan terkaya karbon di kawasan tropis. (https://www.cifor.org/publications/pdf_files/infobrief/3773-infobrief.pdf. Akses dan unduk tanggal 16 Agusutus 2021).

Dlouhá, J., Burandt, S., 2015. *Design and evaluation of learning processes in an international sustainability oriented study programme*. In search of a new educational quality and assessment method. Journal of Cleaner Production, 106, 247-258.

Hake, R. R. (1998). Interactive-Engagement Versus Traditional Methods: A Six-Thousand Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics, 66*(1), 64-74.doi:10.1119/1.18809.

Kalsoom, Q.,and Khanam, A. (2017). Inquiry into Sustainability Issues by Preservice Teachers: A Pedagogy to Enhance Sustainability Consciousness: Journal of Cleaner Production. https://doi.org/ 10.1016/j.jclepro.2017.07.047.

Kalsoom, Q., Khanam, A., and Quraishi, U. (2017). Sustainability Consciousness of Preservice Teachers in Pakistan:International Journal of Sustainability in Higher Education, https://doi.org/10.1108/IJSHE-11-2016-0218

Olsson, D., Gericke, N., 2016. The adolescent dip in students' sustainability consciousness—Implications for education for sustainable development. The Journal of Environmental Education, 47(1), 35-51.

Olsson, D., Gericke, N., Chang Rundgren, S., 2016. The effect of implementation of education for sustainable development in Swedish compulsory schools–assessing pupils' sustainability consciousness. Environmental Education Research, 22(2), 176-202.

Setyawan, D., A & WInarno, K. (2016). Pemanfaatan Langsung Ekosistem Mangrove di Jawa Tengah dan Penggunaan Lahan di Sekitarnya; Kerusakan dan Upaya Restorasinya. Biodiversitas, 7(3), 282-291.

Tilbury, D. (2011). 'Education for Sustainable Development: An Expert Review of Processes and Learning' Paris: UNESCO. Available in Spanish, French and English.ED-2010/WS/46.