



THE IMPLEMENTATION OF LOCAL ENVIRONMENTAL PROBLEM-BASED LEARNING STUDENT WORKSHEETS TO STRENGTHEN ENVIRONMENTAL LITERACY

E. Suryawati^{*1}, F. Suzanti¹, Zulfarina¹, A. R. Putriana², L. Febrianti³

¹Department of Biology Education, Faculty of Teacher Training and Education, Universitas Riau, Indonesia

²Graduated Students, Faculty of Teacher Training and Education, Universitas Riau, Indonesia

³Public Junior High School Kampar Riau, Indonesia

DOI: 10.15294/jpii.v9i2.22892

Accepted: January 8th 2020. Approved: Xth 2020. Published: June 30th 2020

ABSTRACT

The science learning material about Environmental Pollution and Global Warming in Junior High School is very much related to the latest environmental issues. This study aims to examine the relationship between Environmental literacy with thinking skills, actions, and sensitivity to environmental issues through the implementation of Local Environmental Problem Based Learning for Student Worksheets. The survey method was used in this study, followed up by a quasi-experimental design pretest-posttest. Samples of this study were 372 students in three junior high schools located in areas affected by forest fires. Research instruments were in the form of tests, to measure ecological knowledge, and questionnaires that were adapted from the Middle School Environmental Literacy Survey (MSELS), to measure cognitive skills, actions, and sensitivity to the environment. Before being used, questionnaires and tests adapted from MSELS were tested on 35 respondents with a reliability test $\alpha = 0.68$ and a questionnaire $\alpha = 0.88$. Correlations between two variables were analyzed using Path-Analysis with AMOS 23 software. The results of the study showed that there was a direct correlation between ecological knowledge and increased thinking skills. Knowledge is indirectly correlated with action ($\beta = 0.01$, $t = 1.07$, $p > 0.05$) and sensitivity ($\beta = 0.00$, $t = -0.38$, $p > 0.05$). Knowledge ($\beta = 0.12$, $t = 10.43$, $p < 0.001$) correlates directly to thinking skills and acts as a mediator between knowledge, action, and sensitivity to the environment. The result of the effectiveness test of Local Environment-Problem Based Learning (LE-PBL) student worksheets using the pretest-posttest design showed that LE-PBL is effective in increasing the environmental literacy of students, with N-gain value of 0.2 in the control class and N-gain of 0.4 in the experimental class. The implementation of learning resources in the form of LE-PBL student worksheets strengthens students' environmental literacy in identifying, analyzing, evaluating, and planning actions and sensitivity to local and global environmental issues.

© 2020 Science Education Study Program FMIPA UNNES Semarang

Keywords: project-based learning; environmental literacy; local issue

INTRODUCTION

One global problem that becomes the main focus is environmental issues (Bick et al., 2018; Nash et al., 2019; Singh, 2017). From the results of surveys and comprehensive studies conducted by the World Economic Forum (WEF), environmental issues are a global threat. Economic dis-

parity, social polarization, and the intensification of environmental hazards are problems that will be faced by the world population within the next ten years. From 1990 to 2017, the availability of secondary peat swamp forests in Riau decreased from 40,000 km² to 10,000 km² due to fires on peat swampland (Adrianto et al., 2020). The results of the WEF survey on country sustainability assessed from environmental, social, and government

*Correspondence Address

E-mail: evi.suryawati@lecturer.unri.ac.id

(ESG) aspects show that Indonesia is ranked 54th out of 65 countries, which means that Indonesian sustainability is still very low (WEF, 2017). Indonesia also has similar socio-scientific problems, relating to pollution due to waste (Giesler, 2018; Lestari & Trihadiningrum, 2019; Sulaeman et al., 2018), environmental damage due to illegal mining (Macdonald et al., 2014; Muslihudin et al., 2018), also forest and land fires (Adrianto et al., 2020; Syaufina, 2018; Tata et al., 2018).

Forest fires in Riau Province have occurred since 1997 until now. In 2015, forest and land fires that occurred in five districts became local, national, and regional problems that needed to be solved together (BPS, 2016; Suryani, 2012). Forest fires not only have an impact on the level of social, economic, cultural, and ecological life in the affected area. Besides, the problem of domestic waste is also an issue that has occurred in the city of Pekanbaru since 2016. The waste that has accumulated and scattered, besides causing odors, is also a source of various diseases and soil pollution. Pekanbaru City produces 407.72 tons of garbage/day, and only about 80% can be processed, while the remaining 81.54 tons accumulate on the side of the road, and residential areas. Singingi River water quality based on the average results of Chemical Oxygen Demand (COD) ranged from 138.91-143.31 mg/l, exceeding the threshold of 50mg /l. Other impacts caused by environmental damage in the form of loss of water catchment areas in the hills, damage to the landscape, silting rivers, increased erosion, and the occurrence of large puddles filled with water mixed with chemical waste. In terms of health, these activities cause skin diseases such as itching and ulcers (Johan, 2012; Rezki et al., 2017).

Environmental issues, socio-scientific issues, and authentic issues related to environmental pollution and global warming material are discussed in science learning in grade VII of Junior High School. Students, in this case, as learners, are expected to be responsive and sensitive to local environmental issues in gold mining activities, domestic waste, also forest and land fires. By analyzing these environmental issues, students will be trained to relate them to the learning material, so students can take action and find solutions to those problems. Learning experiences are designed for practicing the ability to observe, question, experiment, associate, and communicate (Ghozali, 2017; Tata et al., 2018; Susilana, 2014). Other learning experiences that can be provided are through scientific activities at the School Literacy Movement that aims to foster ecosystems and environments that are conducive to educati-

on. Study results by Suryawati et al. (2018) showed that 61.05% of junior high school science teachers had integrated basic literacy in learning through various activities, like interpreting images, making arguments, making conclusions, and presenting the results of problem-solving. To develop student literacy, printed and non-printed learning resources are needed. One of the most needed learning resources is student worksheets based on contextual issues and authentic issues in the surrounding environment. The availability of learning resources is expected to encourage interest in reading, motivation, and strengthening student literacy.

Authentic problems that are studied in the development of learning resources come from environmental issues, which are illegal gold mining, domestic waste, also forest and land fires. A preliminary assessment of 50 junior high school students in the affected areas showed 54% of students' knowledge of the issue. Furthermore, 70% of the respondents answered that the teacher had never previously provided information about authentic issues from the surrounding environment. A survey of other junior high school students showed that out of 95 people, only 29 students (30.52%) knew how to solve environmental issues in the form of forest and land fires issues. Moreover, 43.87% of 98 students were able to analyze local environmental issues (Putriana et al., 2020; Suzanti et al., 2019). The ability of middle school students in identifying, analyzing issues, and planning actions to practice solving environmental issues is still low. Following science learning at school, students are required to be sensitive and responsive to problems in their environment. The use of contextual learning resources as a means is to improve literacy, sensitivity, and action to overcome environmental issues.

One meaningful learning effort can be made by facilitating student learning through problem-based learning (PBL). Problems that are solved through PBL are authentic problems that are found in everyday life (Tan, 2003). Problem-based learning can increase motivation which has an impact on improving problem-solving abilities (Argaw et al., 2017). The implementation of PBL in schools can provide a conducive learning environment for students and parents (Craig & Marshall, 2019). Sugiharto et al. (2019) stated that the success of PBL implementation was determined by the learning experiences in the classroom and other learning environments. In this study, the learning experience provided is in the form of identifying problems in the surrounding environment through a scientific approach. This activity

is not only to increase environmental knowledge and literacy but also to train sensitivity and ultimately will trigger students' actions to save the environment.

Authentic problem-based student worksheets and scientific approaches will facilitate students' learning to think critically and creatively to create enthusiasm, optimism, and self-confidence through "let's try, think big, let's work, and let's experiment" (Suryawati, 2017). Rahayu et al. (2018) stated that the developed student worksheet could be used to improve thinking skills through an integrated skills process that includes components formulating problems, formulating hypotheses, determining variables, and defining operational definitions. Besides, student worksheets can facilitate student social interactions such as working together, listening and paying attention to peers' opinions, collecting data, discussing work procedures, and sharing information. According to Prana et al. (2018), student worksheets using PBL can improve students' critical thinking skills and self-efficacy. Furthermore, Yustina & Kapsin (2017) stated that constructivism-based student worksheets could improve student competencies and build their knowledge on the topic of forest and land fires.

The results of the study by Liu et al. (2015) showed that knowledge and attitudes are not correlated with environmental action. Teachers who have a high level of knowledge and attitude towards the environment are inversely proportional to the actions or actions taken. Furthermore, Liu et al. (2015) concluded that there are factors that mediate knowledge and attitude with action. Varoglu et al. (2017) found that knowledge of the environment is related to attitudes and behavior. However, attitudes towards the environment have a moderate correlation with knowledge and behavior, whereas knowledge of the environment and behavior has a low correlation. In research on interventions related to environmental education,

the impact of environmental education programs on students' critical thinking has not been much studied. According to Kinslow et al. (2019) and Chang et al. (2017), SSI-based learning through discussion and argumentation on social science issues can positively influence student attitudes toward scientific literacy, environmental literacy, and socio-scientific reasoning. The findings in Taiwan show that teachers are lacking in training the students' ability to discuss and argue. They only focus on the knowledge read from textbooks. Therefore, teachers need to include knowledge and competencies related to environmental education in learning and teaching.

Based on a preliminary study and problem identification, this study aims to investigate the correlation of the environmental literacy of junior high school students with thinking skills, actions, and sensitivity to the environment. The issues used are related to the environment and nature, studied on the topic of environmental pollution and global warming in the seventh grade of junior high school. Gold mining is related to water pollution, forest fires related to air pollution and global warming, and domestic waste related to soil pollution—student worksheets based on local environmental issues that are implemented in science learning in junior high schools.

METHODS

The survey method was used in this study, followed up by a quasi-experimental design pretest-posttest. The survey was conducted on 372 grade VII Junior High School students in three affected areas in Riau. Samples were collected using cluster sampling methods based on the focus of environmental issues using PBL stages that were modified at the problem orientation stage (Creswell, 2013; Tan, 2003). There are three school clusters in this study, which are forest fires, gold mining, and domestic waste.

Table 1. Distribution of Study Samples by Location, Gender, and Focus Issues

School	Number	Gender		Focus of Environmental Issue
		Women	Man	
Cluster 1	149	83	66	Gold Mining
Cluster 2	128	73	57	Domestic Waste
Cluster 3	95	49	46	Land & Forest Fires

Investigations are carried out to measure knowledge, thinking skills, actions, and sensitivity to the environment. The instrument used was an MSLES (Middle School Environmental Literacy Survey) test sheet and questionnaire adapted from Hollweg et al. (2011). Ecological knowledge variables were measured using multiple-choice tests consisting of 20 questions. Variables of thinking, action, and sensitivity to the environment using a questionnaire with Likert scale. The details of the instruments can be seen in Table 2. Before being used, test questions and questionnaires were tested on 35 junior high school students with a reliability test $\alpha = 0.68$ and a questionnaire $\alpha = 0.88$ (Jackson, 2016). Next, the correlation among variables was analyzed using path analysis with the help of Software Analysis of a Moment Structures (AMOS) 23.0 to determine the intercorrelation among the variables studied (Kline, 2015).

Table 2. Measurement of Variables Using the Multiple-Choice Test and Questionnaire

Instrument	Variable	Number of Items
Test	Ecological knowledge	20
	Thinking of environment	12
Questionnaire	Action	12
	Sensitivity	11

Student worksheets using PBL models based on local environmental issues (LE-PBL student worksheets) were developed through the stages of design, self-evaluation, content validity, constructs and criteria by experts using validation sheets, one to one evaluation and small group trials on 15 students and 3 science teachers (Dick et al., 2005; Plomp, 2013). The LE-PBL student worksheet consists of three issues, namely: (1) gold mining for water pollution; (2) the issue of domestic waste for soil pollution, and (3) the issue of forest and land fires for air pollution. The LE-PBL syntax used consists of problem orientation, problem identification, scientific investigation, the work presentation, and analyzing and evaluating the problem-solving process (Tan, 2003).

LE-PBL student worksheet effectiveness test is used to improve environmental literacy and student learning outcomes. The effectiveness test was carried out by quasi-experimental using a pretest and posttest design (Creswell, 2003) on VII graders of Junior High School with 31 people in the experimental class and 31 people in the

control class. The experimental class used the LE-PBL student worksheet on the subject matter of environmental pollution with five meetings. Meeting one is about environmental pollution; meeting two is about integrated water pollution issues of gold mining; meeting three is about integrated soil pollution domestic waste issues; while meetings 4 and 5 are integrated air pollution forest and land fires issues. In the control class, the implementation of learning uses teacher worksheets that have not been validated by the teacher. Assessment in the experimental class during learning process is done when students work on student worksheets on indicators of identifying, analyzing, evaluating issues, and planning actions. Data on environmental literacy and cognitive learning outcomes on environmental pollution material were analyzed using t-test with IBM SPSS Ver 23 software.

RESULTS AND DISCUSSION

Data analysis from the MSLES test using AMOS 23.0 aims to predict the correlation between variables used. The use of AMOS is based on the view that this study has met the requirements, theoretical basis, sample size, and assumptions proposed so that the use of AMOS is considered appropriate (Kline, 2015). The results of the Structural Equal Modeling (SEM) analysis showed a hypothetical structural model at, $\chi^2 / df = 2.98$, RMSEA = 0.06, TLI = 0.91, and CFI = 0.93. The overall assessment measures produce a model that matches the loading factor to all variables from 0.65 to 0.89 with acceptable criteria > 0.50 (Hair, et.al., 2010). Based on the analysis, the study model and the correlations between variables of knowledge, thinking, action, and sensitivity are obtained, as shown in Figure 1.

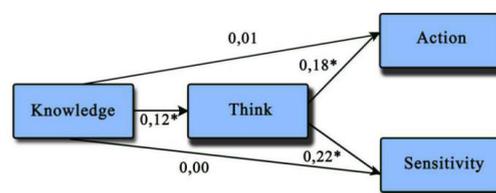


Figure 1. Correlation Model of Knowledge, Thinking, Action, and Sensitivity to Environmental Issue

Based on Figure 1, it can be explained that knowledge does not correlate directly with action ($\beta = 0.01, t = 1.07, p > 0.05$) and sensitivity ($\beta = 0.00, t = -0.38, p > 0.05$). Knowledge ($\beta = 0.12, t = 10.43, p < 0.001$) has a positive correlation with thinking about the environment. The impact of mediators can be seen in Table 3.

Table 3. Impact of Mediator Variables Thinking Ability on Action and Sensitivity to Environmental Issues

Path	Direct effect		Indirect effect		Results
	β	K-value	B	K-value	
K -> T -> A	0.01	0.28	0.18	0.001	Full mediation
K-> T -> S	0.00	0.70	0.22	0.001	Full mediation

Note: K: Knowledge; T=Thinking; A: Action; S: Sensitive

LE-PBL student worksheet that has been developed is continued at the product effectiveness testing stage. The Effectiveness Test was conducted on 62 students of SMPN 1 Kampar, Riau Province, using quasi pretest and posttest design experiments. Learning in the experimental class (31 people) was carried out using the LE-PBL student worksheet five times.

Description of environmental literacy on aspects of identifying, analyzing, evaluating issues, and planning actions can be seen in Figure 3. Students' critical thinking skills can be seen in Table 4, and differences in learning outcomes of the control class and the experimental class can be seen in Table 5

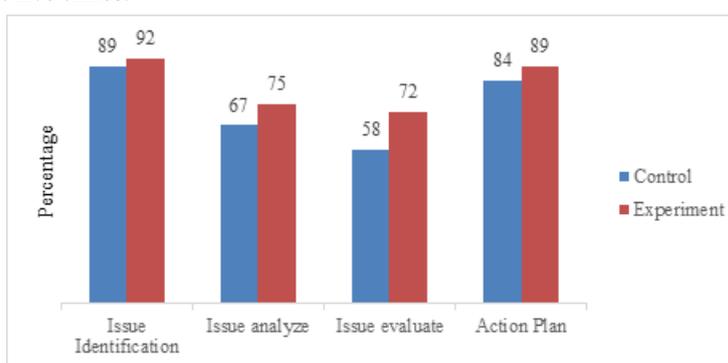


Figure 2. Profile of Environmental Literacy Aspects of Thinking Skills

The ability in analyzing and evaluating issues is still low so that it will impact on action and sensitivity. The results of this study indicate that planning for action is good. That is, students already know what should be done, but not fol-

lowed by real action. For this reason, it is crucial to practice students' thinking skills by facilitating contextual learning based on authentic problems in the surrounding environment.

Table 4. Comparison of Critical Thinking Ability Values between Control Class and Experimental

Indicator of Critical Thinking	Control Class		Experimental Class	
	Pretest	Posttest	Pretest	Posttest
Provide a simple explanation	82	84	82	90
Build basic skills	68	77	58	79
Conclude	66	68	47	76
Provide further explanation	47	53	39	60
Develop a strategy	58	69	73	82
Average	64	70	60	77

The ability to think critically in the experimental class is better, especially in giving simple explanations, developing strategies, and building necessary skills in observing and collecting data.

Next, give an explanation based on the facts they observe and find from the learning resources provided. Learning outcomes between the two groups can be seen in Table 5.

Table 5. Interval of Learning Outcomes of Control Class and Experimental Class

Interval	Category	Control		Experimental	
		Pretest	Post Test	Pretest	Posttest
$X \geq 85$	Very good	0	6	0	9
$75 \leq X < 85$	Good	7	7	7	15
$65 \leq X < 75$	Average	11	10	9	7
$55 \leq X < 65$	Poor	9	8	6	0
$X < 55$	Very poor	4	0	9	0

Based on the data in Table 4 and Table 5, it can be seen that the ability to analyze and evaluate issues is still low such as answers to questions on student worksheets in image interpretation.

The difference in average and improvement in learning outcomes (N-Gain) can be seen in Figure 3.

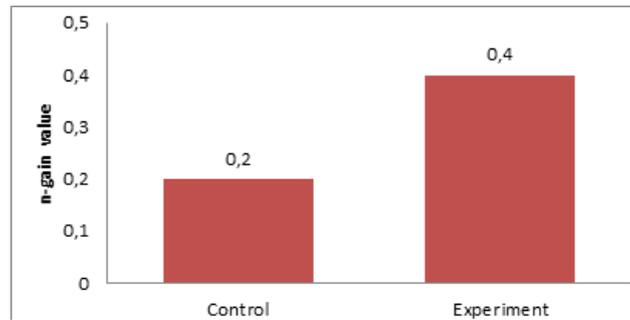


Figure 3. N-gain Value of Control Class and Experimental Class

Based on the correlation models of knowledge, thinking skills, action, and sensitivity to environmental issues, it can be explained that aspects of attitude, such as action and sensitivity to the environment cannot be directly enhanced simply by practicing higher-order thinking skills. The use of student worksheets with the integration of environmental issues is a critical factor for balancing cognitive, affective, and psychomotor aspects.

Thinking skills are full mediators of knowledge about action and sensitivity to the environment. This study obtains the cognitive and affective components that significantly influence environmental behavior. That is, knowledge does not directly affect action and sensitivity to the environment. Real conditions in the field show that most students know that disposing of trash must be in the space provided. However, when they see trash scattered, they do not necessarily take action because junior high school students have not been able to think systematically. The study by Levy et al. (2018) found that most dimensions of

cognitive aspects are significant predictors of environmental behavior. Cognitive aspects include system thinking, action-related knowledge, and cultural knowledge. Affective aspects include environmental awareness, willingness to act for the environment, and human position in systems and centers of control (humanity's place in the system and locus of control).

The correlation of knowledge and thinking, as well as its relation to student involvement in solving environmental issues, has been tested by (Ampuero et al., 2015). He found that critical thinking and empathy that were applied together could help to respect the environment, especially unsafe environments. Furthermore, the knowledge factor is not directly correlated to the attitude towards the environment. Erhabor & Don's study (2016) shows that there is no direct correlation between knowledge and attitudes towards the environment. It is consistent with the results of the study that students' knowledge of the environment is not positively correlated with attitudes and actions towards the environment. Therefore,

it can be said that knowledge can influence action and sensitivity through the intermediary of the ability to think. The correlation between knowledge and attitudes towards the environment is not significant, as is the correlation between knowledge and behavior towards the environment. It is predicted that there are common factors that might influence the correlation between knowledge and attitudes with behavior (Liu et al., 2015). In this case, critical thinking to identify, analyze, and evaluate issues to bring action and sensitivity to the environment.

Environment-based learning is effective in increasing students' attitudes and knowledge (Schmitz & Rocha, 2018). This study found a correlation between increased knowledge of student attitudes with knowledge between male and female students did not affect attitudes. From the results of a survey, the effects of personality and behavioral responsibilities on the environment show that there is a direct influence between personality and intention to take action. Besides, there is a direct influence between intentions to act on responsible behavior towards the environment. This study also shows that students need learning and activities related to the environment, as stated by Pratiwi et al. (2019). The practice of environmental education will directly enhance one's ability to obtain, change, and apply environmental knowledge that accumulates in the right attitude towards the environment (Zheng et al., 2017).

Optimization of increased sensitivity to the environment can use the school environment as a source of learning and enhance behavior towards a responsible environment by increasing the naturalist intelligence and personality of the students (Wirdianti et al., 2019). Other efforts are carried out through strengthening the content of environmental material in the education curriculum in secondary schools. It will be followed by increasing attitudes and behaviors (Varoglu et al., 2017). Some activities are carried out to increase students' sensitivity to the environment through the school literacy movement. The prototype development of an integrated student worksheet on local environmental issues is expected to be able to train activities to identify, analyze, evaluate issues, and plan actions against local environmental issues. The results of the self-evaluation are used as input for revision. The revised student worksheet was validated by a panel of 4 experts stating that the contents, constructs, and criteria were appropriate. It shows that the student worksheet that has been developed has the feasibility to be continued in the stage of one to one evaluation

by interviewing five respondents and continued with a small group trial. One of the activities in the LE-PBL student worksheet is conducting a water pollution practicum, which is guided by practicum videos. Video is equipped with a barcode to facilitate students in accessing learning. Video visualization that has a barcode with the YouTube Link: <https://youtu.be/TLryikOmT6I> aims to facilitate access and facilitate teachers and students in carrying out practical work to see the effect of mercury on fish life.

The ability to analyze and evaluate issues in this study is facilitated by providing discourse, videos of gold mining activities, forest fires, and urban waste. The activity gives a simple explanation as a primary means to practice thinking skills. Give a simple explanation through oral presentations and writing when working on student worksheets as a means of developing basic literacy. Environmental education materials based on social science and PBL issues can help improve students' environmental literacy (Kinslow et al., 2019; Febriasari & Supriatna, 2017). Maclean and Pavlova (2017) stated that PBL is one of the primary forms or learning approaches that must be used to improve the effectiveness of environmental education. The findings of Fenny et al. (2019) showed that PBL could significantly improve students' environmental literacy. The results of the Raath & Golightly's study (2017) showed that PBL-based fieldwork can enrich students' perspectives on environmental issues and can increase the ecological literacy of community growth.

Problem-based learning needs to be applied by teachers to improve ecological understanding and science-based issues so that students' skills in connecting authentic problems can provide solutions and efforts towards environmental issues. So, utilizing local environmental issues with environmental topics is very important both in science classrooms and the outside environment (Lewinsohn et al., 2015; Burek & Zeidler, 2015; Heard, 2016). Discussing environmental issues during learning begins by orienting problems with official videos and images, collecting, analyzing data and presenting it in tables and figures; this not only trains data literacy but also trains students' sensitivity to the surrounding environment. Good sensitivity will lead to actions to preserve and save the environment.

The use of LE-PBL student worksheets in the experimental class provides increased thinking skills for environmental issues. The ability to think critically in the experimental class is higher than the control class. According to the

study of Pratiwi et al. (2016) learning using the socio-scientific Issue (SSI) problem as a learning context has a significant influence on the critical thinking skills of secondary school students. The controversy that arises on the issue will encourage students to discuss and debate to practice critical thinking skills. When students solve some environmental issues and take action, they will help restore the environment and form pro-environment habits. LE-PBL integrated learning also trains students to work together to solve problems and involve students in problem-based learning to help increase knowledge and strengthen essential concepts in ecological knowledge and the ability to think about the environment.

LE-PBL student worksheets are an effective learning resource for increasing environmental literacy. The results of environmental literacy on students' cognitive skills in the experimental class are better than the control class in identifying, analyzing, evaluating issues and planning actions. The design of learning resources in the form of pedagogical-based student worksheets for the ongoing learning process by providing cases of high air pollution encourages students to think in terms of science, health, social, environment, and economy. Through pedagogical-based learning activities, sustainability competencies, and authentic assessment of internal and external competence of students can be developed (Susilowati et al., 2019; Wanchana et al., 2019). According to Pursitasari et al. (2020), the activities of observation, investigation, representation, conclusions, and communication in learning can improve critical thinking skills.

Furthermore, according to Sumarni & Kadarwati (2020), students' creative thinking skills can be achieved if students can come up with original ideas in solving problems. According to Pursitasari et al. (2020), implementation of project-based learning in the form of student worksheets can improve environmental literacy. Implementation of LE-PBL in the form of student worksheets can improve environmental literacy. Furthermore, students who have environmental knowledge tend to have a responsible attitude towards the environment through mediators' thinking skills

CONCLUSION

The implementation of project-based learning in the form of student worksheets of science learning in junior high school is effective in increasing action and sensitivity to the environment through mediating variables of thinking skills.

Learning activities in the LE-PBL student worksheet train students to identify, analyze, evaluate issues, and plan actions on the environment. The LE-PBL student worksheet has been tested for its effectiveness and has a significant effect on improving student learning outcomes between the experimental class and the control class with n-gain of 0.2. Further studies are needed to increase action and sensitivity to environmental issues through the use of various learning resources.

ACKNOWLEDGEMENTS

Support for this project was funded by thesis research grant Directorate General of Research, Technology and Higher Education through the Center of Research and Community Service University of Riau. We would like thank to Principal, Teachers, and student of Junior High School Singingi Riau, and everyone who help this research.

REFERENCES

- Adrianto, H. A., Spracklen, D. V., Arnold, S. R., Sitanggang, I. S., & Syaufina, L. (2020). Forest and Land Fires Are Mainly Associated with Deforestation in Riau Province, Indonesia. *Remote Sensing*, 12(1), 3.
- Ampuero, D., Miranda, C. E., Delgado, L. E., Goyen, S., & Weaver, S. (2015). Empathy and critical thinking: Primary students solving local environmental problems through outdoor learning. *Journal of Adventure Education & Outdoor Learning*, 15(1), 64-78.
- Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2017). The Effect of Problem Based Learning (PBL) Instruction on Students' Motivation and Problem Solving Skills of Physics. *EUR-ASIA Journal of Mathematics, Science & Technology Education*, 13(3), 857-871.
- Bick, R., Halsey, E., & Ekenga, C. C. (2018). The global environmental injustice of fast fashion. *Environmental Health*, 17(1), 92.
- Burek, K., & Zeidler, D. L. (2015). Seeing the forest for the trees! Conservation and activism through socioscientific issues. In *EcoJustice, citizen science and youth activism* (pp. 425-441). Springer, Cham.
- Chang, H. C., Wang, N. Y., Ko, W. R., Yu, Y. T., Lin, L. Y., & Tsai, H. F. (2017). The effectiveness of clinical problem-based learning model of medico-jurisprudence education on general law knowledge for Obstetrics/Gynecological interns. *Taiwanese Journal of Obstetrics and Gynecology*, 56(3), 325-330.
- Craig, T. T., & Marshall, J. (2019). Effect of project-based learning on high school students' state-mandated, standardized math and science

- exam performance. *Journal of Research in Science Teaching*, 56(10), 1461-1488.
- Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and mixed methods*.
- Creswell, W. (2013). John. 2013. *Qualitative inquiry and research design: Choosing among five approaches*.
- Dick, W., Carey, L., & Carey, J. O. (2005). The systematic design of instruction.
- Erhabor, N. I., & Don, J. U. (2016). Impact of Environmental Education on the Knowledge and Attitude of Students towards the Environment. *International Journal of Environmental and Science Education*, 11(12), 5367-5375.
- Febriasari, L. K., & Supriatna, N. (2017, September). Enhance environmental literacy through problem based learning. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012163). IOP Publishing.
- Fenny, R., Ghofar, C. W. A., & Ipah, B. M. (2019, January). The Effect of Problem Based Learning for Student's Environmental Literacy. In *1st International Conference on Education and Social Science Research (ICESRE 2018)*. Atlantis Press.
- Ghozali, I. (2017). Pendekatan Scientific Learning Dalam Meningkatkan Prestasi Belajar Siswa. *Pedagogik: Jurnal Pendidikan*, 4(1).
- Giesler, K. (2018). The Plastic Problem: Plastic Pollution in Bali.
- Hair, J. F., Anderson, R. E., Babin, B. J., & Black, W. C. (2010). *Multivariate data analysis: A global perspective* (Vol. 7): Pearson Upper Saddle River.
- Heard, M. J. (2016). Using a problem-based learning approach to teach students about biodiversity, species distributions & the impact of habitat loss. *The American Biology Teacher*, 78(9), 733-738.
- Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). Developing a framework for assessing environmental literacy. *Washington, DC: North American Association for Environmental Education*.
- Indonesia, B. P. S. (2016). *Statistik Lingkungan hidup Indonesia*.
- Jackson, S. L. (2015). *Research methods and statistics: A critical thinking approach*. Cengage Learning.
- Johan, T. I. (2012). Dampak Penambangan Emas Terhadap Kualitas Air Sungai Singingi Di Kabupaten Kuantan Singingi Provinsi Riau. *Jurnal Ilmu Lingkungan*, 5(02).
- Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-scientific reasoning and environmental literacy in a field-based ecology class. *Environmental Education Research*, 25(3), 388-410.
- Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.
- Lestari, P., & Trihadiningrum, Y. (2019). The impact of improper solid waste management to plastic pollution in Indonesian coast and marine environment. *Marine pollution bulletin*, 149, 110505.
- Levy, A., Orion, N., & Leshem, Y. (2018). Variables that influence the environmental behavior of adults. *Environmental Education Research*, 24(3), 307-325.
- Lewinsohn, T. M., Attayde, J. L., Fonseca, C. R., Ganade, G., Jorge, L. R., Kollmann, J., ... & da Rocha, P. L. (2015). Ecological literacy and beyond: Problem-based learning for future professionals. *Ambio*, 44(2), 154-162.
- Liu, S. Y., Yeh, S. C., Liang, S. W., Fang, W. T., & Tsai, H. M. (2015). A national investigation of teachers' environmental literacy as a reference for promoting environmental education in Taiwan. *The Journal of Environmental Education*, 46(2), 114-132.
- Macdonald, K. F., Lund, M. A., Blanchette, M. L., & Mccullough, C. D. (2014). Regulation of artisanal small scale gold mining (ASGM) in Ghana and Indonesia as currently implemented fails to adequately protect aquatic ecosystems.
- Maclean, R., & Pavlova, M. (2017). What Type of Pedagogy Is Required in Schools and Classrooms to Support Sustainable Green Growth? A Case Study of Hong Kong Within the International Context. In *Life in Schools and Classrooms* (pp. 101-119). Springer, Singapore.
- Muslihudin, M., Bambang, A. N., Hendarto, E., & Putranto, T. T. (2018). The Process of People Gold Mining in Paningkaban Village Banyumas Indonesia. In *E3S Web of Conferences* (Vol. 31, p. 09003). EDP Sciences.
- Nash, N. C., Whitmarsh, L. E., & Capstick, S. (2019). Perceptions of local environmental issues and the relevance of climate change in Nepal's Terai: Perspectives from two communities. *Frontiers in Sociology*, 4, 60.
- Plomp, T. (2013). Educational design research: An introduction. *Educational design research*, 11-50.
- Prana, I. G. L. A. A., Sadia, I. W., & Swasta, I. B. J. (2018). Pengembangan LKS Sains dengan Setting Model Pembelajaran PBL untuk Meningkatkan Keterampilan Berpikir Kritis dan Efikasi Diri. *Thinking Skills and Creativity Journal*, 1(2), 66-75.
- Pratiwi, R. D., Rusdi, R., & Komala, R. (2019). The effects of personality and intention to act toward responsible environmental behavior. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 5(1), 169-176.
- Pratiwi, Y. N., Rahayu, S., & Fajaroh, F. (2016). Socio-scientific issues (ssi) in reaction rates topic and its effect on the critical thinking skills of high school students. *Jurnal Pendidikan IPA Indonesia*, 5(2), 164-170.
- Pursitasari, I. D., Suhardi, E., Putra, A. P., & Rachman, I. (2020). Enhancement of Student's Critical Thinking Skill through Science Context-based Inquiry Learning. *Jurnal Pendidikan IPA Indonesia*, 9(1), 97-105.
- Putriana, A. R., Suryawati, E., Suzanti, F., & Zulfarina, Z. (2020). Socio Scientific Issue (Ssi) Based

- Lkpd Development In Learning Natural Science Smp Class Vii. *Jurnal Pajar (Pendidikan dan Pengajaran)*, 4(1), 80-89.
- Raath, S., & Golightly, A. (2017). Geography Education Students' Experiences with a Problem-Based Learning Fieldwork Activity. *Journal of Geography*, 116(5), 217-225.
- Rahayu, Y. S., Pratiwi, R., & Indana, S. (2018, January). Development of biology student worksheets to facilitate science process skills of student. In *IOP Conference Series: Materials Science and Engineering* (Vol. 296, No. 1, p. 012044). IOP Publishing.
- Rezki, M., Zulkarnaini, Z., & Anita, S. (2017). Kajian Dampak Penambangan Emas Tanpa Izin (PETI) Terhadap Lingkungan Sungai Batang Kuantan Kecamatan Kuantan Mudik Kabupaten Kuantan Singingi Riau. *Jurnal Ilmu Lingkungan*, 11(2), 106-115.
- Schmitz, G. L., & Rocha, J. B. T. (2018). Environmental education program as a tool to improve children's environmental attitudes and knowledge. *Education*, 8(2), 15-20.
- Singh, R. L. (Ed.). (2017). *Principles and applications of environmental biotechnology for a sustainable future*. Springer Singapore.
- Sugiharto, B., Corebima, A. D., & Susilo, H. (2019). The Pre-Service Biology Teacher Readiness in Blended Collaborative Problem Based Learning (BCPBL). *International Journal of Instruction*, 12(4).
- Sulaeman, D., & Arif, S. S. (2018, April). Trash-polluted irrigation: characteristics and impact on agriculture. In *IOP Conference Series: Earth and Environmental Science* (Vol. 148, No. 1, p. 012028). IOP Publishing.
- Sumarni, W., & Kadarwati, S. (2020). Ethno-Stem Project-Based Learning: Its Impact to Critical and Creative Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, 9(1), 11-21.
- Suryani, A. S. (2012). Penanganan Asap Kabut Akibat Kebakaran Hutan di Wilayah Perbatasan Indonesia. *Jurnal Aspirasi*, 3(1), 59-75.
- Suryawati, E. (2017). Pengembangan lembar kerja siswa biologi SMA berbasis pendekatan ilmiah untuk meningkatkan keterampilan berfikir siswa. *Jurnal Pendidikan Biologi*, 6(2), 91-99.
- Suryawati, E., Suzanti, F., Suwondo, S., & Yustina, Y. (2018). The implementation of school-literacy-movement: Integrating scientific literacy, characters, and HOTS in science learning. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 4(3), 215-224.
- Susilana, R. (2014). Pendekatan saintifik dalam implementasi kurikulum 2013 berdasarkan kajian teori psikologi belajar. *edutech*, 13(2), 183-193.
- Suzanti, F., Suryawati, E., & Dipuja, D. A. (2019, November). The Reconstruction of Environmental Education Curriculum Based on Kkni through the Integration of Character Value of Environmental Care and Disaster Response. In *Proceedings of the UR International Conference on Educational Sciences* (pp. 426-430).
- Syaufina, L. (2018). Forest and Land Fires in Indonesia: Assessment and Mitigation. In *Integrating Disaster Science and Management* (pp. 109-121). Elsevier.
- Tan, O. S. (2003). Problem-based learning innovation. *Singapore: Thomson*.
- Tata, H. L., Narendra, B. H., & Mawazin, M. (2018). Forest and land fires in Pelalawan District, Riau, Indonesia: Drivers, pressures, impacts and responses. *Biodiversitas Journal of Biological Diversity*, 19(2), 494-501.
- Varoglu, L., Temel, S., & Yilmaz, A. (2017). Knowledge, attitudes and behaviours towards the environmental issues: Case of Northern Cyprus. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(3), 997-1004.
- Wanchana, Y., Inprom, P., Rawang, W., & Ayudhya, A. O. J. N. (2019). A Model of Environmental Education Competency Development for Teachers in Secondary Schools. *International Journal of Environmental and Science Education*.
- WEF (World Economic Forum). (2017). The Global Risks Report 2017.
- Wirdianti, N., Komala, R., & Miarsyah, M. (2019). Naturalist intelligence and personality: An understanding students' responsible environmental behavior. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 5(2), 229-236.
- Yustina, Y., & Kapsin, K. (2017). The Implementation of Constructivism-Based Student Worksheets Within the Theme 'the Prevention of Land and Forest Fire' in Science Education for Grade VII of Secondary Schools in Riau. *Jurnal Pendidikan IPA Indonesia*, 6(2), 298-305.
- Zheng, Q., Xu, A., & Kong, D. (2017). Environmental education, knowledge management and professional performance in eco-tourism: The impact relatedness. *EURASIA Journal of Mathematics Science and Technology Education*, 13(8), 4679-4687.