

Research Article

Effect of problem-based learning on critical thinking skills and environmental attitude

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Abstract

The purpose of this study was to: (1) to determine the effect of problem-based learning (PBL) model on critical thinking skill, and (2) to determine the effect of PBL model on environmental attitude. This study used a quasi-experiment model with a pretest-posttest control group design. The subjects of this study were students of Social Sciences Education Program, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia, academic year 2018/2019. The sampling technique used purposive sampling and determined 25 subjects in each experimental and control class. Data collection used a test as an instrument of critical thinking skill and a questionnaires that were used to know the students' environmental attitude. The data analysis used independent sample t-test. The results showed: 1) there is a significant influence of PBL model on students' critical thinking skill ($p=0.010$) and 2) there is a significant influence of PBL model on students' environmental attitude ($p=0.000$). The PBL model has higher influence on critical thinking skill and environmental attitude than to conventional model. The use of problem-based learning models in activities to solve environmental problems encourages students' critical thinking skills to foster an environmental attitude.

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Introduction

The environmental attitude of students majoring in Social Science Education Study Program at Maulana Malik Ibrahim State Islamic University of Malang, Indonesia is still considered low. They are less concerned the condition of the campus' environment and classroom which are dirty since they assume that cleaning the trash is the cleaning service staff's task. This is an ironic phenomenon because students have already studied Introduction to Geography lesson which discusses sustainable environment. The Minister of Environment and Forestry, Siti Nurbaya states that the percentage number of the people's ignorance concerning trash is still relatively high (Rolando, 2019), it is including students who play a role as academic society living in Indonesia even in the world. Learning activities should be able to nurture environmental attitude (Suwanto, 2013). However, in fact, learning about environment in higher education institution does not merely alter students' attitude toward their surrounding environment. Their environmental attitude is not fully affected by the knowledge they mastered.

Critical thinking skills are very crucial to be developed in learning about the environment since environmental attitude is not only influenced by the students' mastery of knowledge. As a part of academic society, students are expected to be able to preserve and converse the environment as well as overcome the environmental problems so that the environmental attitude will grow within them (Fua, Wekke, Sabara & Nurlila, 2018). However, in reality, most

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students do not have awareness on the campus environment. The lack of knowledge about environment can inhibit the students' critical thinking skill and awareness toward environment (Ahmadi, 2018).

Critical thinking skill is not only implemented during the learning process, but it is also reflected in the environmental attitude. In daily life, critical thinking skill is necessary as a step to preserve the environment sustainability. The environmental attitude is not merely about the concept, but it means more about the contextual meaning of the critical thinking concerning the way of preserving the environment so that it can be beneficial for the present and future time (Puspitasari, Sumarmi & Amirudin, 2016). Critical thinking skill can be implemented during the effort of nurturing environmental attitude. This attitude or character is not only conveyed conceptually, but also contextually. Critical thinking skill is needed to be taught deeply so that students can understand the condition of their environment where they live better. The skill must be developed from the learning objective formulation that is made based on the environmental condition surrounds them. The learning objectives, according to Puspitasari et al. (2016) are to make students able to: (1) explicate the definition of environment; (2) identify the quality of the environment; (3) analyze the environmental damage; (4) determine the proper action for overcoming environmental damage; and (5) create the example of the proper action for preserving the environment and sustainable development. Based on the description, it can be concluded that the variable of critical thinking ability is directly proportional to the environmental attitude. Students with high critical thinking skills are assumed to have high environmental attitudes.

The learning regarding sustainable development of environment taking place in Social Science Education class is considered conceptual only and it does not truly train students to think critically to overcome the environmental problems; thus, it does not nurture the environmental attitude, while actually critical thinking is one of crucial competencies in this information age of the 21st century. Students are required to have this skill to face the global problems (Ditjen Sumber Daya Iptek Dikti, 2018). Therefore, learning efforts are needed to be performed to foster students' critical thinking skill to make them aware of their surrounding environment.

The rational efforts implemented to instill critical thinking skill and environmental attitude by implementing Problem Based Learning. PBL is one of the innovative learnings proposed by Howard Barrows in McMaster University School of Medicine, Canada in 1969 (Anderson, 2007; Savery, 2006; Savin-Baden & Major, 2004). PBL model is implemented in the learning process to resolve the real problems (Orozco & Yangco, 2016) scientifically (Amir, 2013) through a series of investigation (Trianto, 2009) in order to obtain any problem solving. The real problems happened in the environment surrounding the students are directed as a stimulus to start the learning activity using PBL (Sumarmi, 2012). By facing the real problem, students grow more enthusiastic in collecting information, investigating problems, and overcoming the environmental problems properly.

One of the advantages of PBL model is affects the environmental attitude character (Dochy, Segers, Bossche, & Struyven, 2005; Hemker, Prescher, & Narciss, 2017; Huijser, Kek, & Terwijn, 2015; Kuvac & Koc, 2018). Wibowo (2013) defines environmental attitude as an action or effort to prevent environmental damages and try to fix them. Through PBL model, environmental attitude can be developed based on the ability to overcome problems (Lestari, 2015). PBL model triggers students to participate in a long life learning (Masek & Yamin, 2011; Selçuk, 2010), by giving them a real problem in daily life (Birgili, 2015). Hence, an authentic problem-based learning can develop students' character in behaving wisely towards the environment (Supriatna, 2016). The results of the study revealed by Djuandi (2016) indicate that High School students have experienced an improvement in terms of attitude towards the environment. Furthermore, Susanti et al. (2017) concluded that the environmental attitude of junior high school students taught using the PBL model is better than the control class. Students can understand the material and work together through small groups to solve problems, so that students grow aware of themselves to care about their environment.

Another excellence of PBL model is the possibility to develop a critical thinking skill (Akınoğlu & Tandoğan, 2007; Allison & Pan, 2011) through a scientific method (Kronberg & Griffin, 2000). During the problem solving process, students are able to refine their critical thinking skills (Bashith & Amin, 2017; Mundilarto & Ismoyo, 2017; Pusparini, Feronika & Bahriah, 2018; Ramadhani, Huda & Umam, 2019). Students are able to analyze and synthesize every single problem they face (Nasution et al. 2016), so that several problem solvings can be obtained rather than only one problem. Based on the results of the study conducted by Yuan et al. (2008), PBL model is recommended to enhance students' critical thinking skill since students share their ideas with each other in looking for a solution. The result of study shown by EL-Shaer & Gaber (2014) indicate that a significant improvement of students' critical thinking skill shows up after implementing PBL model. Students can relate each concept and integrate those concepts with a real problem. This process will surely trigger students' critical thinking skill within students.

Based on the characteristics and advantages of the PBL model, it is assumed that the use of PBL model in classroom can improve critical thinking skills and students' environmental attitudes. This study focuses on the effect of PBL on critical thinking skills and environment attitudes, because there has not been much research on PBL with these variables. Several studies have been conducted by Sari, Jamil & Jayanti (2017), Pebriana & Disman (2017), Yanto & Yerizon (2018), Yulia, Farida, & Yuni (2018), Pusparini et al. (2018), and Herzon, Budijanto, & Utomo (2018) only know the effect of PBL on critical thinking skills without the variable of environmental attitude.

The PBL learning stages applied in the study are adopted from Arends (2004). The description of the steps in using the problem-based learning model in detail can be seen in table 1 below.

Table 1.
Syntax of Problem Based Learning Model

| Steps | Procedures | Student Activities |
|--------|---|--|
| Step 1 | Problem Oriented | Students are given environmental problems surround them. Students understand the details of the issues to be discussed. |
| Step 2 | Organized Oriented | At this stage, students can group the details of the issues discussed and find out how to solve problems. |
| Step 3 | Investigations Guide as Individual or Group | Students conduct an investigation to solve the environmental problems. Students can investigate the problem individually or in groups. |
| Step 4 | Attainments Development and Presentations | Students explicate the results of the problem solving through class presentations. At this stage, students can compare steps to solve other problems and find steps to solve the most appropriate problem. |
| Step 5 | Problem Solving Analysation and Evaluation | Students perform an analysis and evaluation on the process of overcoming the environmental problems. Students can conclude the correct and appropriate problem solving. |

Problem of Study

The research problem was the low students' critical thinking skills and students' environmental attitudes. The PBL model in this study was implemented in a Geography lesson, particularly for a sustainable development topic that discusses the environmental syndrome around the students. This research was conducted to discuss problems;

- Is there an effect of problem-based learning model on students' critical thinking skill?
- Is there an effect of problem-based learning model on students' environmental attitude?

Method

Research Model

The method of the study is quasi experiment. The reason of using quasi experiment model is triggered by the fact that the writer cannot fully control both groups that are studied since it is impossible to control all external variables. Thus, the alteration occurred is not completely affected by the treatment given. The quasi experiment design employed in this study is the pretest-posttest control group design (Campbell & Stanley, 1973; Sugiyono, 2011) as seen in table 2 below.

Table 2.
The Pretest-Posttest Control Group Design

| Group | Pretest | Treatment | Posttest |
|--------------|----------------|-----------|----------------|
| Experimental | O ₁ | X | O ₂ |
| Control | O ₃ | | O ₄ |

O1: Pretest for experimental class O2: Posttest for experimental class
X: Learning with PBL model O3: Pretest for control class O4: Posttest for control class

Participants

The research subjects were students of Social Science Education Program, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia, academic year 2018/2019. They have taken a geography course with sub-material of Sustainable Environmental Development. The sampling technique used purposive sampling, where subjects were taken based on the characteristics of the same academic ability between the experimental and the control class. The subjects in this study, namely class A as an experimental class amounted to 25 students and class B as a control class amounted to 25 students.

Data Collection

Critical Thinking Skill Test (CTST): The instrument for assessing critical thinking used essay test based on the indicators of critical thinking skill by Ennis (1995) as in table 3. The critical thinking skill test has been tested for validity with correlation techniques of product moment and reliability with the method of Kuder Richardson 20 (Purwanto, 2005). The test result of the instrument showed that the item of critical thinking skill test was valid (table 4) and reliable (KR20=0.756).

Table 3.

The Indicators of Critical Thinking Skill

| No. | Critical Thinking Skill | Indicator |
|-----|-------------------------|---|
| 1. | Formulate the problem | - Formulate in the form of questions to give the directions and to get answers |
| 2. | Give the argumentation | - Give the argumentation that suitable with the reason - Show the differences and the similarities of it - Give a complete argument |
| 3. | Perform deduction | - Deduct logically - Interpretation logical condition for statements. |
| 4. | Perform induction | - Investigate/collect data. - Make generalizations from data - Create the table and graphic. - Explain the logical assumption |
| 5. | Perform evaluation | - Evaluation is given based on fact. - Evaluation is given based on principle and orientation - Give an alternative |
| 6. | Determine and implement | - Choose the possible solution - Determine the implemented possibilities |

Table 4.

The Result of Validity Test for Critical Thinking Skill

| Item Number | r Count | r Table | Classification |
|-------------|---------|---------|----------------|
| 1 | 0.882 | 0.496 | Valid |
| 2 | 0.578 | 0.496 | Valid |
| 3 | 0.731 | 0.496 | Valid |
| 4 | 0.622 | 0.496 | Valid |
| 5 | 0.587 | 0.496 | Valid |
| 6 | 0.653 | 0.496 | Valid |

The assessment instrument of environmental attitude used questionnaires that measured with Likert scale with a value 1–5. The indicators of environmental attitude consists of 1) protect the environmental sustainability; 2) provide the information about environmental management; 3) protect and improve the environment; and 4) share the solutions for the environmental problems (Yaumi, 2016). The instrument of environmental attitude has been tested for validity with correlation techniques of product moment and reliability with the method of Cronbach's Alpha. The test result of the instrument showed that the item of environmental attitude test was valid (table 5) and reliable (Alpha=0.740).

Table 5.*The Result of Validity Test for Environmental Attitude*

| Item Number | r Count | r Table | Classification |
|-------------|---------|---------|----------------|
| 1 | 0.760 | 0.4869 | Valid |
| 2 | 0.632 | 0.4869 | Valid |
| 3 | 0.601 | 0.4869 | Valid |
| 4 | 0.514 | 0.4869 | Valid |

Data Analysis

Data analysis in this study used normality test, homogeneity test, and independent sample t-test with significance of 0.05. Hypothesis testing of critical thinking skill in this research was as follows.

H₀: there was no difference in critical thinking skill of the students before and after the implementation of the PBL model.

H₁: there was a difference in critical thinking skill of the students before and after the implementation of the PBL model.

Hypothesis testing of environmental attitude in this research was as follows.

H₀: there was no difference in environmental attitude of the students before and after the implementation of the PBL model.

H₂: there was a difference in environmental attitude of the students before and after the implementation of the PBL model.

The criteria are:

If there is sig. \geq 0.05, H₀ is accepted.

If there is Sig. $<$ 0.05, H₀ is rejected.

Results**Data of Critical Thinking Skill in Experimental and Control Class**

Data of critical thinking skill is tested using normality test with One-Sample Kolmogorov-Smirnov Test method and homogeneity test with Levene's Test method (Purwanto, 2005). The result shows that data of critical thinking skill is normally distributed (table 6) and has homogeneous variety (table 7).

Table 6.*The Result of Critical Thinking Skill Data Normality Test*

| One-Sample Kolmogorov-Smirnov Test | Gain Score |
|------------------------------------|----------------------------------|
| N | 50 |
| Normal Parameters ^a | Mean Std. Deviation |
| | 18.5000 12.00553 |
| Most Extreme Differences | Absolute Positive Negative |
| | .095 .095 -.091 |
| Kolmogorov-Smirnov Z | .669 |
| Asymp. Sig. (2-tailed) | .761 |

Based on table 6, it shows sig. = 0.761 $>$ α = 0.05. It means that the data is normally distributed.

Table 7.*The Result of Critical Thinking Skill Data Homogeneity Test*

| Levene Statistic | df1 | df2 | Sig. |
|------------------|-----|-----|------|
| .615 | 1 | 48 | .437 |

Based on table 7, it shows sig. = 0.437 $>$ α = 0.05. It means that the data is homogeneous variety.

The data of critical thinking skill that has been tested using normality test and homogeneity test is tested again using an independent sample t-test. The summary of the t-test analysis result can be seen in table 8.

Table 8.

The Result of Critical Thinking Skill T-Test Analysis

| Variable | N | Mean | T | Df | SD | Sig. (2-tailed) |
|--------------------|----|-------|-------|-------|----------|-----------------|
| Experimental Class | 25 | 22.80 | 7.878 | 48.00 | 12.16895 | 0.010 |
| Control Class | 25 | 14.20 | 7.878 | 46.83 | 10.37625 | 0.010 |

Based on table 8, there is a significant difference between the gain score of the critical thinking skill in experimental class and control class. It is proven by the calculation of the independent sample t-test valued at $\text{sig.} = 0.010 < \text{sig.} = 0.050$. It means that H_0 was rejected and H_1 was accepted. Thus, it can be concluded that there is differences in critical thinking skill of the students before and after the implementation of the PBL model. The average of gain score of the experimental class was higher, 22.80, than the control class, 14.20. Thus, it shows that the PBL model has an effect on improving critical thinking skill of students.

Data of Environmental Attitude in Experimental and Control Class

The result shows that data of environmental attitude is normally distributed (table 9) and has homogeneous variety (table 10).

Table 9.

The Result of Environmental Attitude Data Normality Test

| One-Sample Kolmogorov-Smirnov Test | Unstandardized Residual |
|------------------------------------|-------------------------|
| N | 25 |
| Normal Parameters ^a | Mean |
| | .0000000 |
| | Std. Deviation |
| | 1.05689922 |
| Most Extreme Differences | Absolute |
| | .132 |
| | Positive |
| | .132 |
| | Negative |
| | -.085 |
| Kolmogorov-Smirnov Z | .662 |
| Asymp. Sig. (2-tailed) | .773 |

Based on table 9, It shows $\text{sig.} = 0.773 > \alpha = 0.05$. It means that the data is normally distributed.

Table 10.

The Result of Environmental Attitude Data Homogeneity Test

| Levene Statistic | df1 | df2 | Sig. |
|------------------|-----|-----|------|
| .009 | 1 | 48 | .926 |

Based on table 10, It shows $\text{sig.} = 0.926 > \alpha = 0.05$. It means that the data is homogeneous variety.

The data of environmental attitude that has been tested using an independent sample t-test. The summary of the t-test analysis result can be seen in table 11.

Table 11.

The Result of Environmental Attitude T-Test Analysis

| Variable | N | Mean | T | Df | SD | Sig. (2-tailed) |
|--------------------|----|-------|-------|-------|---------|-----------------|
| Experimental Class | 25 | 16.44 | 4.168 | 48,00 | 1.93821 | 0,000 |
| Control Class | 25 | 14.16 | 4.168 | 47,99 | 1.92959 | 0,000 |

Based on table 11, there is a significant difference between the score of the environmental attitude in experimental class and control class. It is proven by the calculation of the independent sample t-test valued at $\text{sig.} = 0.000 < \text{sig.} = 0.050$. It means that H_0 was rejected and H_2 was accepted. Thus, it can be concluded that there is differences in environmental attitude of the students before and after the implementation of the PBL model. The average of gain score of the experimental class was higher, $\bar{X} = 16.44$, than the control class, $\bar{X} = 14.16$. Thus, it shows that the PBL model has an effect on improving students' environmental attitude.

The comparison of the average score of students' environmental attitude in the two classes is visualized in Figure 1 below.

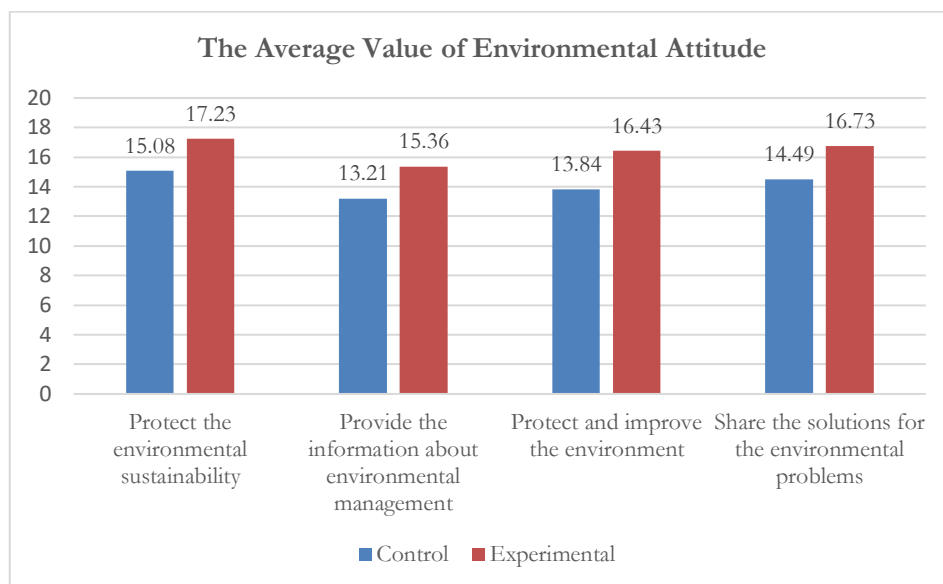


Figure 1.

The Average Value of Environmental Attitude

Based on figure 1, there are differences in the average score of environmental attitudes between the experimental class and control class. In general, the average score of environmental attitude in the experimental class is higher than the control class in all indicators. The average score of environmental attitude on 1) indicator of protecting the environmental sustainability in the experimental class amount $\bar{X}= 17.23$ and in the control class amount $\bar{X}= 15.08$; 2) indicator of providing the information about environmental management in the experimental class amount $\bar{X}= 15.36$ and in the control class amount $\bar{X}= 13.21$; 3) indicator of protecting and improving the environment in the experimental class amount $\bar{X}= 16.43$ and in the control class amount $\bar{X}= 13.84$; and 4) indicator of sharing the solutions for the environmental problems in the experimental class amount $\bar{X}= 16.73$ and in the control class amount $\bar{X}= 14.49$. The conclusion from the data shows that the PBL model has a higher effect on the environmental attitude in the experimental class than the control class.

Discussion

PBL Model Effects on Critical Thinking Skills

High critical thinking skill obtained because students are more active during the learning in the class by using the PBL model. This is inseparable from the learning characteristics of PBL, viz, 1) problem based (Arends, 2004; Sumarmi, 2012); 2) problem solving (Hmelo-Silver, 2004); and 3) reflective in transferring knowledge (Anderson, 2007; Gwee, 2009). PBL model provides the convenience to the students in solving problems, because it presents contextual problems that occur in their surrounding environment. Students are active in constructing their knowledge through discussions and questions based on real problems (Narmaditya, Wulandari, & Sakarji, 2018). Students are able to understand the environmental problems encountered and make it easy for them to investigate for obtaining the data to find the solution the problems. This encourages the critical thinking skill of the students maximally because they can develop their curious attitude more. They can also how to be objective, independent, critical, and analytical both in individual and in group (Sumarmi, 2012). Learning of PBL is focused on the problems that makes students can develop their own knowledge, develops their inquiry skill and develops their critical thinking skill. Students must be able to formulate the temporary answers for the problems that require logical intelligence, courage, and active solutions in real situation (Mulyanto, Gunarhadi, & Indriayu, 2018).

When the students discuss in their group, they can solve the living environmental problems that happened around them. It is because they students try hard to solve the problems. This encourages their critical thinking skill developing (Akinoğlu & Tandoğan, 2007) because they can empower, sharpen, test, and develop their thinking skill (Kamil, Velina, & Kamelia, 2019). The use of PBL model can develop students' critical thinking skill, besides enriching knowledge. The thinking process is a series of skills such as gathering information/data, reading data, and others application that requires practice and habituation (Sumarmi, 2012).

PBL model enables students to learn about how to solve the problems through group discussion. It can be seen on the stages of research and investigation of the group. They can practice and share their ideas when they try to solve the problems in the group. Using PBL model also makes the students doing discussion and doing a question and answer activity so that they can increase their understanding (Koestiningih, 2011). Solving environmental problems require the activities that suitable with the indicators of critical thinking such as analyze and evaluate (Saputra, Joyoatmojo, Wardani, & Sangka, 2019). The contributions of ideas from the members of the group make their knowledge increase. Therefore, they can share their suggestion about how to solve the environmental problems. Reasoning skill and the contribution of their ideas indicate the students' critical thinking processes (Birgili, 2015).

Students plan the problem in PBL to support their critical thinking development. Learning using PBL provides the students with opportunity to explore their thinking, so they have to write down systematic solution and actively discuss during the learning process (Saregar et al. 2018). They can explore the problem in order to accelerate their critical thinking to find the solution in a form of scientific writing (Camacho & Christiansen, 2018). The writing process trains them to think critically, since they have to present their ideas in group and find a solution for the problem (Herzon, Budijanto & Utomo, 2018).

The use of real world problem in the learning process becomes one characteristic of PBL approach to train the student to think more critically and to be able to solve problems (Al-Fikry, Yusrizal & Syukri, 2018). PBL model guides students to find facts, make a hypothesis, and draw conclusion during problem solving. After that, they have to choose the best solution and make an operational idea in detail. Related activities through PBL model steps indirectly train the students to concentrate (Yulia, Farida & Yuni, 2018) PBL model guides students to find facts, make a hypothesis, and draw conclusion during problem solving. After that, they have to choose the best solution and make an operational idea in detail. Related activities through PBL model steps indirectly train the students to concentrate (Sari, Jamil & Jayanti, 2017). They actively build their knowledge and habit to think critically during PBL model (Yanto & Yerizon, 2018). It enables the, to survive when they face daily problems (Istikomah, Basori & Budiyanoto, 2017).

The focus of PBL model is on the chosen problem, so the students have an opportunity to learn concepts related with the problem itself and scientific method to develop their critical thinking. PBL model prepare the students to think critically and analytically in using suitable learning source (Pebriana & Disman, 2017). They collect information by reading relevant references to solve problems in their environment (Widiawati, Joyoatmojo & Sudiyanto, 2018). It is in accordance with Marni, Suyono, Roekhan & Harsiati (2019) stating that PBL model prepare students to be communicative, collaborative, creative, innovative, critical, and analytical in thinking and able to solve real world problem effectively.

PBL Model Effects on Environmental Attitude

PBL model on sustainable environment material implemented in the experimental class consists of examples on environmental problems. Environmental problem solving needs to be done repeatedly to motivate the students to take care their sustainable environment and to build their environmental attitude (Zecha, 2010). The attitude is built because the students feel that they have a responsibility to take care their environment (Wesnawa, Christiawan & Suarmanayasa, 2017).

Based on the result findings, PBL model has a positive effect on environmental attitude. The high score of environmental attitudes after PBL model shows that students' environmental attitude can improve. The mean score of environmental attitude of the experimental class is higher since PBL consists of several learning stages to do involving students to actively think in order to solve environmental problems (Hadzigeorgiou & Skoumios, 2013). Students actively build their background knowledge from the beginning until the end of the learning process. Learning activities done by the students lead to a more complex, permanent and integral result in understanding the environmental problems (Kuvac & Koc, 2018).

PBL model provides students with a comprehensive understanding to study environmental problems (Dochy et al. 2005). The study starts from mapping the problem, determining the problem priority, conducting field investigation, discussing group work, and presenting the work related with environmental problems. Such learning encourages students to analyze various facts, events, and environmental problems. They will be able to solve problems, to build logical and critical thinking framework, curiosity, inquiries, and other cognitive skills in order to find the solution for their environmental problems (Sumarmi, 2012).

The students' environmental attitude will improve when they face real problems in their environment (Bergman, 2016). It will trigger them to have a positive attitude toward their environment. The attitude will shape their positive

self-concept in responding and showing behavior which is in accordance with ecological principles (Pe'er, Goldman & Yavetz, 2007).

The new knowledge achieved after PBL model can be used as a consideration in taking decision to behave toward the environment. The research finding of Darmawan (2015) showed that the improvement of environmental attitude on PBL class is higher than that of non-PBL class may due to the fact that the students deal with a real daily problems. They have to solve the problems in group. The open problems in PBL lead students to solve them using various ways of data collection and discussion (Dewi, Sumarmi & Amirudin, 2016). The various information and data can be used to determine various alternative for solving the problems. The new knowledge on environmental destruction prevention can be a foundation for students to behave toward their environment (Tikka, Kuitunen & Tynys, 2000).

The improvement of environmental attitude may also due to the learning process using PBL model in the experimental class. It consists of five stages namely 1) to make problem orientation, the students are given sustainable environmental problems; 2) to organize students to learn and study the material on sustainable environmental problems; 3) to guide individual/group experience, students work in group and agree the discussion result, provide solution for the problem solving process and produce a poster showing environmental attitude; 4) to present and develop a scientific writing, the students in group present a report in a form of discussion result and environmental attitude poster in front of the class; and 5) to evaluate the problem solving process. Using PBL steps, the students are able to achieve the theories and remember them and also to act as problem solver for their environmental problems (Kuvac & Koc, 2018).

Even though learning and character building have been implemented, the result is not as good as it is expected. Character building needs a longer time and process (Bechtel & Churchman, 2002; Levine & Strube, 2012). The development of environmental attitude is through a socialization process and a long duration and it is affected by various factors such as care for environment and role models at home, school and in the society (Raharjo, 2010). The evaluation of environmental attitude needs a deepening process and reflection, to find out its strength and weakness (Abun, 2017). It is supported by the research of Pratiwi, Sarwi & Nugroho (2013), stating that character building needs a longer time to emphasize habits which should be done continuously.

Conclusion and Recommendations

Based on the research result that first, the calculation statistic of the independent sample t-test of critical thinking skill valued at $\text{sig.} = 0.010 < \text{sig.} = 0.050$. It means that learning activity using PBL model affects the students' critical thinking. The students' high critical thinking skills in the experimental class caused that during PBL learning, students are trained to think critically to solve real problems in groups (Akinoglu & Tandoğan, 2007; Kamil, Velina, & Kamelia, 2019). Second, the result of environmental attitude t-test is $\text{sig.} = 0.000 < \text{sig.} = 0.050$. It means that the learning activity using PBL model affects the students' environmental attitude. The problem-solving process in PBL learning encourages students to care about their environment. Using PBL steps, the students are able to achieve the theories and remember them and also to act as problem solver for their environmental problems (Kuvac & Koc, 2018). The use of problem-based learning models in activities to solve environmental problems encourages students' critical thinking skills to foster an environmental attitude.

Recommendations for further studies are needs to be done research on the effect of PBL model on other variables such as spatial thinking ability, learning outcomes, students' social sensitivity on the environment, motivation, etc. Further research recommendations can also be carried out in the context of qualitative, quantitative, or development research.

Recommendations for applicants such as lecturers and teachers to implement PBL model, especially in solving problems, because this model is proven to be able to improve students' critical thinking skills and environmental attitude when solving environmental problems. In addition, the researcher recommends that the use of the PBL model in the teaching and learning process should be collaborated with e-learning or through blended learning because the investigation and attainments development stage requires a long time.

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