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Research Article

The effect of problem-based learning and naturalist intelligence on students' understanding of environmental conservation

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ABSTRACT

Environmental conservation understanding is one of the crucial factors which determines student attitudes and behavior towards the environment. This study aimed to investigate the effects of problem-based learning and naturalist intelligence on the students' understanding of environmental conservation. This experimental research was conducted at Madrasah Aliyah Negeri (MAN) 1 Praya which employed factorial design. The first factor was the levels of naturalist intelligence (high and low) and the second factor was learning forms (problem-based and expository learning). Two groups were randomly selected from X-MIPA graders of MAN 1 Praya. The data were collected through tests which then were analyzed using ANOVA at 0.05 significance level. The results of the study indicated that problem-based learning affected the students' understanding of environmental conservation, while naturalist intelligence did not affect it. Furthermore, there were no interaction between these two factors.

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INTRODUCTION

Environmental issues are crucial in this current era (Jianping et al., 2014). Various environmental problems have arisen, such as declining levels of green structures (Roy, Shemdoe, Hulme, Mwageni, & Gough, 2018; Lee et al., 2019), environmental pollution (Dudani, Lakhmapurkar, Gavali, & Patel, 2017; S. Ray & Ray, 2011), decreased food supply (D. K. Ray et al., 2019), and decreasing the land carrying capacity (Roshayanti, Ghofar, Wicaksono, & Budi, 2019; Ichsan, Sigit, Miarsyah, Azrai, & Heryanti, 2019). Then, the current global environmental crisis is also causing damage to forests, soil, the ozone layer (Andrady et al., 2017), until climate change. Furthermore, climate change has resulted in various other disasters (Ghazali et al., 2018). Therefore, environmental problems must be a concern for all parties.

Concern for the environment should be an important variable in controlling environmental quality (Machin, 2014). Environmental concern is a major factor influencing environmental behavior (Pagiaslis & Krontalis, 2014). Furthermore, environmental behavior is significantly correlated with environmental knowledge (Zheng,

Xu, Kong, Deng, & Lin, 2018). In this regard, education have a significant impact on one's environmental knowledge level (Ergen & Ergen, 2011; Erhabor & Don, 2016). Therefore, schools as institutions that are able to improve students' environmental behavior (Tanu & Parker, 2018) and environmental knowledge (Schmitz & Rocha, 2018) must optimize its role.

Unfortunately, in Indonesia, students are still difficult to understand the phenomena occur in their surroundings (Kamaludin, Surtikanti, & Surakusumah, 2018). Based on observations made at MAN 1 Praya, 50% of students have a low level of understanding of environmental conservation (UEC). The observation result showed that the students' UEC is still at the minimum level. As a result, their attitude and behavior toward environmental conservation would also be at the lowest level. Therefore, teaching and learning which enable the students to build their knowledge, attitude, and skills in improving environmental conservation needs to be promoted.

One of the teaching and learning strategies that have potency to develop the students' UEC is problem-based learning (PBL). PBL includes cooperative learning with a student-centered paradigm (Ali, 2019; Karimi, 2011; Qutoshi & Poudel, 2014) which is based on constructivism theory (Gewurtz, Coman, Dhillon, Jung, & Solomon, 2016). In PBL, students are presented with a learning problem which they need to solve (Servant-Miklos, 2019). It requires the students to order their knowledge individually or in group to find solution to a problem (Prasetyant, Sari, & Sajidan, 2016). This instructional model is good to be applied to develop higher-order thinking skills (Ersoy & Baser, 2014; Gholami et al., 2016; Koray & Koray, 2013; Oliveira et al., 2016; Ulger, 2018). It can also strengthen cognitive aspects (Aswan, Lufri, & Sumarmin, 2018; Rotgans & Schmidt, 2011) and attitude toward environment (Kuvac & Koc, 2018; Yasinta & Karyanto, 2016). Therefore, PBL become the preferred pedagogical strategy in higher education (Amoako-Sakyi & Amonoo-Kuofi, 2015).

Beside external factors such as learning form, there are also internal factors that affect students' environmental conservation understanding. One of factors that may affect the understanding is naturalist intelligence (NI). The statement based on (Ningrum, Soesilo, & Herdiansyah, 2018) which informs that someone with a good NI will also have good environmental awareness (EA). However, there are no studies examining the effect of NI on students' UEC. Some of the studies that have been mentioned only examine the existence of a relationship between NI and EA (Ningrum et al., 2018). Several other studies examining NI also limit their research to environmental attitude (Hartika, Diana, & Wulan, 2019). On the other hand, the potential of PBL in increasing UEC is also rarely studied. PBL is often assessed in its potential in various previous studies. However, various studies more often examine the effect of PBL on students' thinking skills (Anugraheni, 2018; Asyari, Muhdhar, Susilo, & Ibrahim, 2016; El-Shaer & Gaber, 2014; Ramdiah, Abidinsyah, & Mayasari, 2018), metacognition (Gholami et al., 2016; Kuvac & Koc, 2019), literacy (Febriasari & Supriatna, 2017; Shultz & Li, 2016; Suwono, Pratiwi, Susanto, & Susilo, 2017), learning outcomes (Nursa'ban, Masykuri, & Yamtinah, 2019; Yew & Goh, 2016), learning motivation (Argaw, Haile, Ayalew, & Kuma, 2017; Koçakoğlu, Türkmen, & Solak, 2010; Thakur & Dutt, 2017), or attitudes (Demirel, 2016; Kuvac & Koc, 2018; Veli, 2014) . In fact, UEC is also a competency that needs to be optimally empowered, especially the increasingly critical environmental conditions at this time. Therefore, the purpose of this study is to examine the effect of PBL and NI on students' UEC.

METHOD

This experimental study was conducted at Madrasah Aliyah Negeri (MAN) 1 Praya, Central Lombok using factorial design. The first main factor is learning form that consist of PBL and expository learning. The research subjects consisted of two randomly selected classes from six classes of grade X-MIPA at MAN 1 Praya. One class is taught using PBL, one class uses expository learning. The topic taught during the study was ecosystem.

The second main factor is NI level that consist of high NI and low NI student. The grouping of the students into high and low NI level was based on the rank of their NI test scores in each sample group. Measurement of students' NI was carried out before the learning treatments through multiple choice test (reliability = 0.81). Indicators of naturalist intelligence refer to Armstrong T. (2009) and Razmjoo (2008). These indicators include the ability to: (1) understand of natural phenomena, (2) understand of natural management, (3) understand of environmental problems and issues, (4) understand of fauna, (5) classify fauna based on similarities and dissimilarities, (6) understand about flora¸ and (7) classify flora based on similarities and dissimilarities. High NI level covered 35% of the students achieving high NI test score and low NI level included 30% of the students achieving low NI test score. Both consist of 11 students.

After the treatments, the measurement of the students' UEC was conducted. The measurement was using test. The instrument of test used has passed the process of expert validation and field validation and have a

high reliability (0.95). Then, the data on the students' UEC were analyzed using descriptive and inferential statistics. Descriptive statistics was used to get a descriptive information about students' UEC level. To determine the UEC level, the students' test result was matched with categories listed in Table 1. On the other hand, inferential statistics chosen in this study was two-way analysis of variance (ANOVA) at 0.05 significance level.

Table 1. Category of the students' understanding of environmental conservation

Score interval	Category
86 – 100	Very high
71 – 85	High
56 – 70	Moderate
40 – 55	Low
0 – 39	Very low

Source: At-Taubany (2017)

RESULTS AND DISCUSSION

Currently, environmental damage occurs everywhere and the frequency of occurrence is increasing. In response, UEC empowerment is seen as needing to be optimized during learning. In this study, the measurement of the students' UEC was carried out after the teaching and learning treatment in the two groups. The data are presented in Table 2.

Table 2. Comparison of UEC test achievement between student taught by PBL and expository learning

Descriptor	Groups			
	PBL		Expository Learning	
	High NI	Low NI	High NI	Low NI
Number of subjects	11	11	11	11
Ideal maximum score	100	100	100	100
Highest score	89	88	84	84
Lowest score	84	85	80	79
Average	86.91	87.00	81.45	81.73
Standard deviation	1.7	0.8	1.2	1.7

Table 2 shows the students' UEC score was differences on several statistical parameters. Students who taught by PBL obtained higher UEC than expository learning, both at high and low NI level. The average of UEC score of high and low NI students taught by PBL were 86.91 and 87.00, consecutively. That mean that students UEC were at very high category. On the other hand, high and low NI students taught by expository learning have average score as high as 81.45 and 81.73, respectively. Both scores are categorized as high category. Therefore, the result indicated that the students taught with PBL have a better UEC than those taught with expository learning.

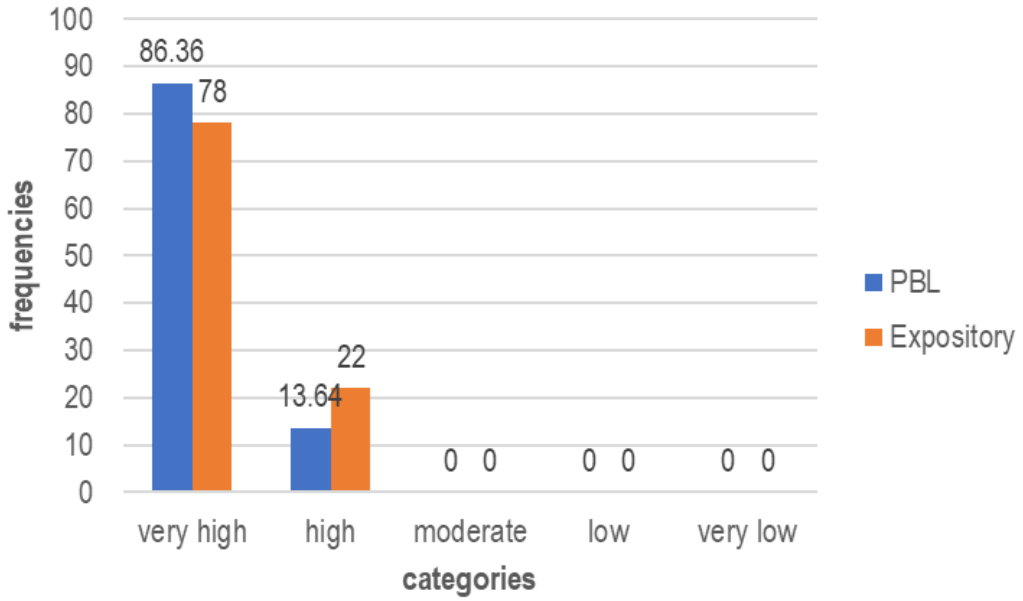

Figure 1. The frequency distribution of students based on the UEC category in both learning form

Then, the frequency distribution graph for each UEC category, both from the group taught by PBL and expository learning is presented in Figure 1. Figure 1 reveals that the students in the PBL group had a greater frequency for 'very high' and 'high' category than those in the expository groups. This signifies that the teaching and learning using PBL has better effect on the students' UEC than using expository learning. Interestingly, after being taught using these two forms of learning, there are no students who are categorized as medium, low, or very low.

After the data was analyzed using descriptive statistics, then the research hypothesis test was performed. Before the hypothesis test was carried out, the prerequisite test was carried out. Data normality test results are presented in Table 3 and homogeneity test results are presented in Table 4. Based on Table 3, the four treatment have significance (Sig.). Value greater than 0.05. Therefore, data for all treatment were declared normally distributed. Table 4 shows that the Levene's Test of equality of variances have Sig. value greater than 0,05. Therefore, the data from four groups were declared to have a homogenous variance.

Table 3. Normality test results

Treatment	Statistic	Significance
High NI in PBL class	0.163	0.200
Low NI in PBL class	0.318	0.073
High NI in expository class	0.183	0.200
Low NI in expository class	0.223	0.134

Table 4. Homogeneity test results

F	Significance
2,909	0.066

After the data was declared normal and homogeneous, hypothesis testing was carried out. The results summary of ANOVA test is presented in Table 5. Based on Table 5, it showed that (1) learning form significantly affected the students' UEC ($F = 151.020$, $p < 0.05$), (2) NI did not significantly affect the students' UEC ($F = 0.174$, $p = 0.679$), and (3) the interaction between PBL and NI did not significantly affect the students' UEC ($F = 0.043$, $p = 0.836$).

Table 5. The summary result of ANOVA test

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Learning form	316.455	1	316.455	151.020	< 0.05
NI level	0.364	1	0.364	0.174	0.679
Interaction	0.091	1	0.091	0.043	0.836
Error	83.818	40	2.095		
Total	312884.000	44			
Corrected total	400.727	43			

The ANOVA results showed that there were significantly differences in the average scores of students' UEC that taught by different learning form. The average final test score of the students' UEC in the PBL group was higher than in the expository group. This means that the students in PBL group has the significantly higher UEC score than expository learning group. The results of the analysis that show the superiority of PBL in improving students' biology concept understanding are in line with some previous studies (Kan'an & Osman, 2016; Rubiah, 2016). Such findings are not only reported in biology subjects, but in other science subjects (Aidoo, Ofori, Boateng, & Kissi, 2016; Aydin, 2014; Shishigu, Hailu, & Anibo, 2018; Tosun & Taskesenligil, 2013). PBL implementation has the positive impact due to it provides students with the opportunity to solve authentic problems through discussion (Yew & Goh, 2016). From discussion activity, they would find the answers of the questions or solve the environmental problems given and seek supporting information or knowledge from variety of resources like internet which enable the students to become more literate. After obtaining the information needed, the students will get a better UEC.

Content of the problems to be presented in the teaching and learning also gave effect on students' UEC in the PBL group. In PBL, the quality of problems had the role of stimulating the students to learning (Boelens, De Wever, Rosseel, Verstraete, & Derese, 2015). In this learning, students were asked to analyze the

problems presented in news or pictures (for example the problem of how abiotic components affected biotic). These activities pushed the students to continue thinking, analyzing, searching for information, selecting necessary and unnecessary information, ordering related facts, making analogy, building logic thinking, thinking about the procedure and materials prepared for an experiment, and designing an experiment to prove the truth of the hypothesis. Such mental activities were carried out by the students every time during the ten meetings of the lesson. As a result, the students get used to thinking hard, and thus the PBL is quite effective for fostering thinking skills of the students in learning biology.

Different condition occurred in expository learning in which learning was carried out in accordance with what the teachers of MAN 1 Praya had planned before. The teachers organized teaching and learning through lecture, group discussions, assignments, and project methods. Lecture was used by the teacher to explain the important materials before the students performing group discussion, doing assignments and working on projects. The method was interspersed with questions and answers which was also conducted by the teacher in two meetings of the lesson. In group discussion, the students were given a number of further questions in which they had to find the answers in groups on the student's course book. After the discussion, the group was given the opportunity to deliver the results of the discussion in front of the class. Project was used by the teachers to give lessons about environmental change. One of the learning objectives to be was the students were able to make a recycling product from rubbish and waste. Here, the students were asked to complete a project, namely making a product by utilizing rubbish and waste.

Expository learning also seems to require students' thinking processes. Two main activities that can improve students' thought processes while participating in expository learning were discussion and project activities. Discussion activities included in effective learning that are reported to have a positive impact in learning biology (Linton, Pangle, Wyatt, Powell, & Sherwood, 2014). On the other hand, project activities provide significant learning experience opportunities for students to excite them and can help them learn challenging content (Zwick, 2018). However, the emphasis and the portion were still very small when compared with PBL. Consequently, the result of test on EUC in classes taught with expository learning were smaller than that in the PBL group. The results is in line with the study conducted by Çakıroğlu & Öztürk (2017) who found that the students had difficulty in explaining the essence of the problems given if they are not confronted directly with authentic problems.

Then, the results of this study also showed that NI had no effect on the students' UEC. Furthermore, the interaction between PBL and NI had no effect on the students' UEC. However, the finding is different from the results of the study by Wirdianti, Komala, & Miarsyah (2019) According to them, there is a relationship between NI and students' pro-environmental behavior (PEB). Although the variables studied are related to the psychomotor domain, but PEB and UEC have links to environmental knowledge (Duan & Sheng, 2018; Zheng et al., 2018). When NI is related to PEB, it is certain that NI is also related to environmental knowledge, because knowledge can be a predictor of behavior (Ajzen, Joyce, Sheikh, & Cote, 2011). In line with Husin's (2017) findings there is the effect of the interaction between learning methods with NI on the students' knowledge about ecosystems concept. Moreover, students with high NI who are taught with problem solving methods have higher knowledge of ecosystem concepts compared to the students' who are taught with learning experience method.

Related to the results of this study, it is indicated that PBL did not only supports the students with high NI for better UEC, but also those with low NI. This condition was affected by the demand of PBL which required all members in groups to actively collaborate each other to analyze and solve the problem (Galvao, Silva, Neiva, Ribeiro, & Pereira, 2014; Yaqinuddin, 2013). Therefore, students with high and low NI can respond well to the teaching and learning activities carried out during PBL.

Based on the discussions that have been expressed, it can be emphasized that PBL is an effective learning model in improving UEC. Learning syntax that directs students to solve environmental problems in an authentic way will increase their knowledge of conservation. Expository learning does not mean unable to empower UEC, but empowerment is less than optimal. Therefore, PBL is highly recommended to be applied in environmental-based learning. UEC empowerment must also be encouraged because this competency is reportedly related to students' attitudes and behavior towards their environment (Cornelisse & Sagasta, 2018). Environmental attitudes often determine the behavior of students who are able to improve or decrease the quality of the environment (Gifford & Sussman, 2012). In the end, if UEC can be empowered properly, PEB will be embedded in every student where PEB will guide their steps to protect the surrounding environment

CONCLUSION

This study informs that PBL has a significant effect on increasing UEC students. On the other hand, NI does not significantly influence the level of competence. Furthermore, the interaction of learning models and NI levels also did not have a significant impact on UEC. Related to the results, PBL should be applied continually in biology learning to develop the students' UEC. Authentic issues about environment need to be stressed in order to increase the UEC. NI does not necessarily to be a basis for consideration in applying problem-based learning to develop the students' UEC. Regarding the findings related to NI, further research that focuses on NI needs to be conducted. The research is expected could to explore the relative contribution of NI to various competencies in environment-based learning. By knowing this information, learning can be designed optimally both for students with high and low NI.

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