PROBLEM-BASED LEARNING: GENERATES HIGHER-ORDER THINKING SKILLS OF TENTH GRADERS IN ECOSYSTEM CONCEPT

Siti Ramdiah*, H. Abidinsyah, and Ria Mayasari
Biology Education Study Program, PGRI Banjarmasin School of Teacher Training and Education
(STKIP PGRI Banjarmasin), South Kalimantan, Indonesia
*corresponding e-mail: sitiramdiah@gmail.com

ABSTRACT
This study aimed to determine the effect of Problem-Based Learning (PBL) model on tenth grader higher-order thinking skills (HOTS) in ecosystem concept. The design of this study was quasi-experimental research with "nonequivalent pretest-posttest control group design". The population of this study was tenth grader in Senior High School (SHS) Kandangan, South Kalimantan. The sample was chosen through random sampling technique. The sample will be tested for equivalence based on the data of from the report card from the first semester. The instrument of data collection is students' HOTS rubric that developed by Hart (1994) with a range of scores for each question ranging from 0 to 4. One way analysis of variance (ANOVA) was used as hypothesis test in this study. The result showed that PBL model had a positive effect on HOTS. It can be seen from the average of HOTS level of control class was 28.40 and treatment class was 36,23 and seen from F value = 20.97 whereas F table = 0.05 means F arithmetic > F table.

Keywords: *Ecosystem concept, HOTS, PBL, skills*

INTRODUCTION

Today, education is the key success of a nation (Simon, Banks, & Bromirski, 2003). Education builds a knowledgeable, cultured, devoted man, who have life skills to compete with the others. Furthermore, the development of science education in a country will affect the country's survival rate to compete with other countries (Cobern, 1998). The reason, the development of science education will affect the development of science and technology to society and the country. The more advanced the development of science and technology of a country, the more ready the country to competes in this era of globalization (Şener & Saridoğan, 2011). It means, education becomes one of the important things to be noticed. Therefore, science education in a country should be designed to prepare resources that master the concept and application of science.

On the one hand, learning science is a process that is not difficult. Everyone can learn science, even children can perform various activities of science in everyday life. On the other hand, learning science is like learning a new language (Roth & Hwang, 2011). In this regard, in some circumstances, learning science is a difficult process. Moreover, various concepts must be mastered by the students and sometimes the concept is abstract and complex (Johnson, 2009). As a result, students' learning outcomes cannot be achieved optimally.

Various alternatives are proposed by various educational experts and researchers to overcome the difficulty of students in understanding the concept of science, including in Biology learning. Basically, to overcome the low learning outcomes, those experts and researcher tried to facilitate students to gain experience in the scientific process as done by real scientists or by utilizing various learning models that are able to facilitate students to learn more actively (Armbruster, Patel, Johnson, & Weiss, 2009; Fauzi, Corebima, & Zubaidah, 2016; Fauzi & Ramadani, 2017). In those alternatives, learning designs often try to concretize the concepts that previously abstract.

A good learning and a good education will produce qualified graduates who are expected to be able to face all these changes. Education can be proven through a process of learning. Successful learning has a positive impact on students' level of understanding and

achievement of expected learning objectives. Furthermore, changes in learning outcomes and student behavior should be noted improving students' higher-order thinking skills or HOTS (Zohar & Dori, 2003). This is important to be observed given the HOTS provide information related to the quality of learning by teachers. These aspects of HOTS are an important part of a learning design. Well-planned plans will have an impact on student learning outcomes as described before.

In line with a good education, Indonesia is currently experiencing various changes in the field of education both in terms of curriculum and application of learning models. The purpose of the change is for the implementation of learning in school to be better than before. But, these changes lead to the need for adaptation by teachers and students in the learning process (Ismail & Fata, 2016). The learning process that used to refer to the teacher center has now led to a student center. This learning approach can improve students' learning performance (Armbruster et al., 2009). Therefore, the teacher should be more innovative in the planning and implementation of the learning process.

However, not a few teachers who still hold learning with the conventional approach. Lecture method often used because it is considered more effective in learning (Cahyadi, 2004). While students' learning outcomes go hand in hand with remedial activities. Moreover, conventional learning such as using lecture method is less able to empower students' thinking skills. It is of particular concern that teachers need to change planning, learning processes and teaching styles to improve students' learning outcome, so that remedial processes can be minimized.

As already mentioned, education now plays an important role in the sustainability of a nation. In this regard, biology learning should empower students to be ready to compete in the global era. One of the competencies to be empowered is HOTS. Thus, the learning design should integrate a potential learning models that could empowering both students' learning outcomes and students' thinking skills (Buku, Mite, Fauzi, Widiansyah, & Anugerah, 2015; Fauzi, 2013; Haryati, Manurung, & Gultom, 2017; Husamah & Pantiwati, 2014; Khasanah & Astuti, 2018; Setiawati & Corebima, 2017). Furthermore, the selected learning model can

certainly guide students to understand the material provided.

One of the learning models that has been believed to improve HOTS is Problem-Based Learning or PBL (Bell, 2010). This learning model has steps that guide students to scientific thinking, determine the problem. According to Suprijono (2009), students during the application of PBL will have investigation skills, the skill to overcome the problem. Students can also become independent and independent learners. It is explained further that the result of learning through PBL is a HOTS.

PBL is one of the innovative models that creates active learning conditions and engages students to solve a problem through a scientific method. Thus the students can learn the knowledge related to the problems encountered and have the skills to solve the problem. Based on this opinion then the teacher can design the learning process and present an effective and quality learning so that knowledge and skills obtained by students more meaningful (Sumantri, 2015). Based on this background, this study aims to determine the effect of PBL model on HOTS of tenth graders in ecosystem concept.

METHOD

The method used in this research was quasi-experimental with Nonequivalent Pretest-Posttest Control Group Design. Treatment in the study was a PBL model and conventional learning as a control. The population was tenth graders of Senior High School (SHS) Kandangan, South Kalimantan, Indonesia. Sample determination using random sampling. The sample will be tested for equivalence based on the data of tenth grader report card one semester in Biology subject.

In this study, students' HOTS is accessed using HOTS rubric developed by Hart (1994) with a range of scores for each question ranging from 0 to 4. The procedure of collecting research data through the following activities: 1) Administering pretest in the treatment class and control class, to know the students' HOTS before applying PBL model and conventional learning. The implementation of the test conducted by researchers together with classroom teachers; 2) Understanding the implementation of learning scenario related to the model of learning that is experimented with model teachers and observers. Furthermore,

observations using learning observation sheets that have been adapted to PBL model. On the observation sheet, the observer selects alternatives "good, enough, less, and not good". The observation was done by the teacher. The implemeter of learning done by a model teacher of research place that has been trained before in applying the model of learning according to the strategy which is an experiment. Activity observation of the implementation of learning stages by the observer is carried out during the implementation of PBL model. Observers make observations by sitting in the classroom during the learning activities; 3) Data collection related Stage 4 PBL learning model that is developing and presenting the work to students in making the work; and 4) Conduct posttest in the treatment class and control class, to know student HOTS after implementation of PBL model. Implementation of the test conducted by researchers together with teachers.

One way analysis of variance (ANOVA) was used as hypothesis test in this study. The level of significance used in hypothesis testing is 0.05 ($p \leq 0.05$). Before hypothesis testing was conducted, the data were tested to determine whether the data meet the assumptions of normality and homogeneity. Hypothesis testing and assumption tests were analyzed using SPSS 17 for Windows.

RESULTS AND DISCUSSION

In this study, student HOTS who received conventional learning and students who received PBL model were measured. Measurements were made at the beginning of the study (pretest) and the end of the study (posttest). The summary of HOTS data is presented in Table 1.

Table 1. Summary of HOTS for tenth graders

Class	N	Mean Pretest	Mean Posttest
Treatment	27	11.67	36.23
Control	27	10.46	28.40
Total	54	11.07	32.32

Based on Table 1, the value of student HOTS in the treatment class was always higher than the control class, either on pretest or posttest. From the data, it appears that students who receive PBL have HOTS that was 21.61%

higher than students who receive conventional learning.

The data that have been collected then was analyzed used hypothesis test that has been determined by research method. Based on the assumption test results, the data met the assumptions of normality and homogeneity. Thus, the data can be continued to be analyzed using one-way ANOVA. Anova test results are presented in Table 2.

Table 2. Summary of one-way ANOVA test on HOTS of tenth graders

Diversity	SS	df	MS	F	Sig.
Between Groups	827.59	1	827.59	20.97	0.000
Within Groups	2052.43	52	39.470		
Total	2880.02	53			

In this study, HOTS measured consist of three indicators: apply, analyze, and evaluate. On each indicator, students receiving PBL learning always have higher scores than students who receive conventional learning. The data of HOTS achievement from each indicator is presented in Figure 1.

Based on Table 2, the significance value (Sig) that obtained was 0.000 <0.05. On the other hand, based on Table 1., the posttest data of the students in the treatment class is higher than the control class. Thus, based on both Table, students who receiving PBL learning have significantly HOTS than students who follow conventional learning. So, it can be said that the PBL model tends to have more potential in improving the thinking skill of class X student on ecosystem concept.

The findings of the study indicate the PBL model can improve students' HOTS on indicators of applying, analyzing and evaluating. The data indicate that these indicators can be improved better through the PBL learning model, although in conventional learning it shows an increase in the average value of HOTS. This provides information that the application of PBL model is potentially better than conventional learning in order to improve HOTS especially on aspects of applying, analyzing, and evaluating the concept. This result is also in line with several previous studies (Fitri & Ramdiah, 2017; Haryati et al., 2017; Magsino, 2014; Sastrawati, Rusdi, & Syamsurizal, 2011; Surya & Syahputra, 2017).
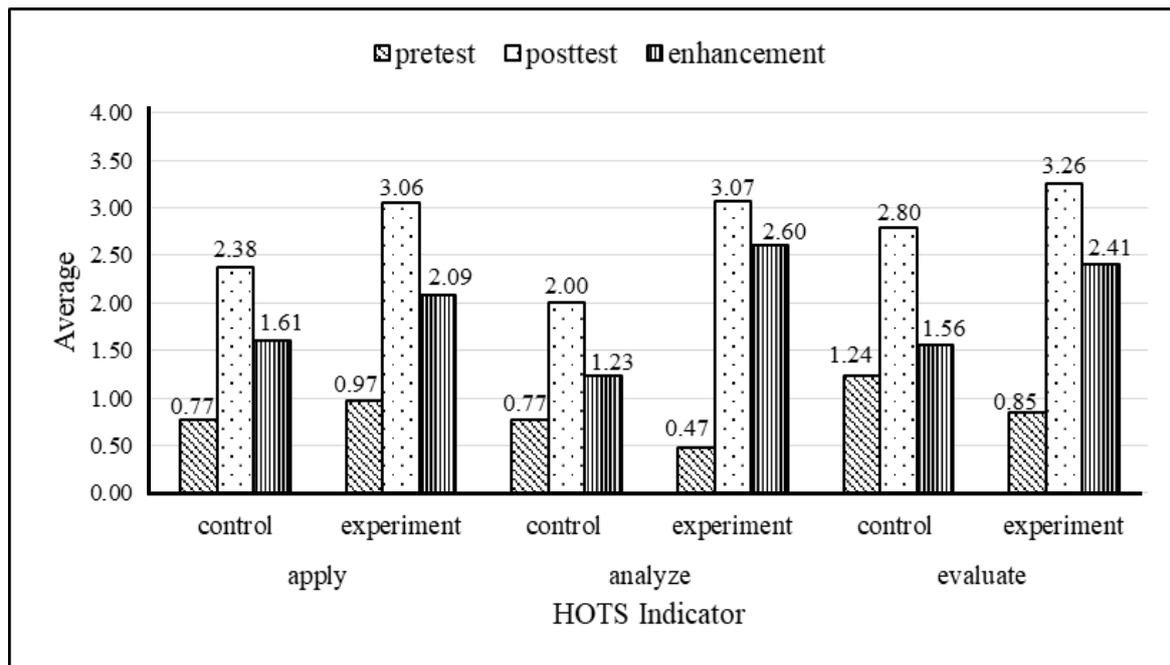
Figure 1. The improvement of student HOTS

The average increase and hypothesis test results indicate the PBL learning model can empower the students' HOTS. PBL model is believed to be able to direct students' thinking, especially on the aspects of synthesizing, evaluate, and apply concepts learned in the learning process (Ganiron Jr, 2014). Through it, the students are able to solve the problem through scientific investigation. According to Moutinho, Torres, Fernandes, and Vasconcelos (2015), PBL helps students to develop new knowledge and contribute to the scientific investigation of the problems posed. Furthermore, Suriansyah and Aslamiah (2014) explain that PBL is one of the learning that provides opportunities for students to conduct the investigation with real and authentic, so as to form and become a habit of students in empowering HOTS. It further explained that besides that PBL also develops students' ability to be more innovative and creative in the task.

In this study, several indicators used as a benchmark of student HOTS are: apply, analyze, and evaluate. Student HOTS who follow PBL are higher than students who follow conventional learning because PBL is able to facilitate students to improve these three skills. In PBL, students are trained to seek and evaluate the information they obtain and apply the information they know to solve the problems at hand (Ganiron Jr, 2014; Haryati et al., 2017; Magsino, 2014). In dealing with these problems, students must also be required to carry out analytical activities (Haryati et al., 2017). Students should also use evaluation skills to determine the strength or weakness of an argument (Magsino, 2014). In addition, they must also evaluate the quality of the results of analysis, interpretation, explanations, choices, opinions, to ideas (Magsino, 2014; Seel, 2012). From these explanations, it is answered why three indicators of HOTS in this study can be more empowered to students who follow the PBL.

Based on the findings of this study can be informed that the results of the research have supported the previous findings. PBL provides more advantages to the learning process in tenth graders in the ecosystem concept. The problems posed at the beginning of the learning to the students can be completed step by step in the PBL model. PBL model guides and directs students to be active and cooperate in solving problems critically (Magsino, 2014). This is done in the sequence where students find problems, define and organize tasks. Next, students jointly find information and conduct investigations. The final stage students are required to empower HOTS, innovative, and creative that is in developing and presenting the work on the problems and solutions. In addition, through the application of this model students are guided to be able to cooperate, be responsible, and have creativity in the work (Ersoy & Baser, 2014).

CONCLUSION

The result showed that PBL model had a positive effect on HOTS. It can be seen from the average of HOTS level of control class was 28.40 and treatment class was 36,23 and seen from F value = 20.97 whereas F table = 0.05 means F arithmetic > F table. Based on the results of the study of the application of PBL model of HOTS in the ecosystem concept, it can be concluded that there is the influence of PBL model to HOTS of tenth graders in ecosystem concept.

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