Indonesian Journal of Biology Education
Vol. 2, No. 2, 2019, pp: 1-7
pISSN: 2654-5950, eISSN: 2654-9190
Email: ijobe@untidar.ac.id
Website: jurnal.untidar.ac.id/index.php/ijobe

Problem-Based Learning Model with Experimental Task Method Triggers Critical Thinking Skills

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Article History

Received : 22 - 05 - 2019
Revised : 06 - 08 - 2019
Accepted : 20 - 08 - 2019

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Keywords:
Critical Thinking Ability;
Experiments Task Method;
Problem-Based Learning

Abstract

The aim of this study is to determine the effect of Problem-Based Learning models with experimental task methods to trigger the critical thinking skills. The ability to think critically is the main needed ability for graduates in the 21st century. This type of research is a quasi-experiment using pre-test and post-test. The population used is the XII grade students of SMA in the 2018/2019 academic year. The research sample used was selected through purposive random sampling. The analysis used is Covariance Analysis. The results showed that the average difference in the value of critical thinking skills of the experimental class students was higher than the control class, which was 31 for the experimental class and 24 for the control class, with significance results (Sig = 0,000). This is because PBL is a learning model that uses contextual problems so that students actively build knowledge and can accommodate the development of critical thinking skills. In conclusion, the Problem-Based Learning model with the experimental task method triggers an increase in students' critical thinking skills compared to conventional learning models as evidenced by the ANACOVA results of significance 0,000 <0.05.

1. INTRODUCTION

The 21st century was marked as a globalization era (Widestra, *et al* ,2018). The education on globalization era can be marked by hyper-competition and revolution of technology which in this case, it could be the opportunity, as well as a challenge that must be faced by each individual (Sudarisman, 2015). To overcome these challenges and opportunities, students are expected to master the learning and innovation skills, including critical thinking (Ali, *et al.*, 2018). This critical thinking ability is the main skill for graduates to prepare and face the 21st century (Tiruneh, 2018).

The education curriculum designed by the government to face the challenges of the 21st century, namely the revised 2013 curriculum has developed the critical thinking potential (Fitrianingsih, *et al* , 2018; Sulardi, *et al.*, 2015). As mentioned by the Education Ministerial regulation of Republic Indonesia 65 of 2013 concerning the education process for primary and secondary education units that senior high school students (SHS) must show the ability to think critically independently. Related to the point above, It can be said that in all learning matters of senior high school, students were required to learn and practice the critical thinking ability (Lutfi, 2017).

The ability to think critically is a process of thinking ability that can be accepted by reflective, rational, and responsible sense of what is done, in which it does not carelessly analyze and draw some unclear, less evidenced conclusions (Sulardi, *et al.*, 2015). According to Piaget's theory of cognitive development, in the age of 12-18 years old, students entering the formal operational stage, which means that students are able to think critically (Suharto, 2017). The mean ages of High school student in class XII are 16-18 years old, so they are required to be able to study and practice the critical thinking.

The ability to think critically can't be achieved by classical method in form of one-sided speech from lecture, it takes some practice and also a critical spirit for students to be able to have critical

thinking ability (Hitchcock, 2017). Ability is the quality of someone to be able to do something, while skill is the ability obtained after practice. This critical thinking ability is defined as the ability of a person to manipulate thinking skills when engaging in critical thinking activities (Chang, *et al.,* 2011). So according to Gueldenzoph, *et al.,* (2008) students who are accustomed to being passive students will find it difficult to grow critical thinking skills and therefore need to be trained. Teachers play an important role in designing the learning activity that can train students' critical thinking skills in order to achieve the learning goals. There are many strategies, methods, and models that can be applied to train students' critical thinking skills, one alternative is to use the *Problem- Based Learning* (PBL) model (Sulardi, *et al*, 2015).

Problem- Based Learning (PBL), is one of the learning models that requires students' mental activities to understand a learning concept through authentic and meaningful situations and problems (Smith, 2016). The purpose of the PBL learning model is to train students to solve some problems using a problem solving approach (Utomo, *et al.,* 2014). The PBL learning model place a student as the center of entire learning process, while the teacher act as a 'facilitator' (Li, 2017). Teachers can design PBL learning activity by providing problems that involve students' thinking abilities and involve the process of analyzing based on actual problems (Nafiah, 2014). The first problem given as a starting point that can be used as a stimulus for the learning process, then it lead to the discovery of relevant knowledge and skills by students to solve or understand the problem (Leong, 2017).

According to Maghfiroh, *et al.,* (2017) learning activity with authentic problems in PBL make students practices their critical thinking skills. The PBL model is also suitable to be applied in biology subjects, especially in biotechnology material that remains abstract. The PBL model will help students on gaining some actual experience. The stimulus and response of the learning process in PBL will connect the two directions learning activity, so that students can work on the authentic problem with their knowledge and increase their critical thinking ability. That was an advantage of PBL in developing student's critical thinking skills (Husnah, 2017).

In addition, students' critical thinking can also be improved through the selection of appropriate learning methods given properly by teacher (Kusumaningtias, *et al*, 2013). One of them is the experimental method, because in the process of giving students direct experience, students are able to find the answers from certain problems by conducting their own experiments and finding evidence from a theories that have been studied (Hasmiati , *et al* , 2017).

This shows that the experimental method is well suitable to be combined with the *problem-based learning* model to improve students' critical thinking skills. That is what makes the reason researchers try to apply PBL learning models with experimental methods in this study. The experimental method carried out in the form of assignments, and experiments given at home.

2. RESEARCH METHODS

The type of this study is a quacy experiment with the " *pre-test and post-test design* ". This study uses two sample classes, one experimental class using the previously mentioned *Problem- Based Learning* (PBL) model with the use of the experimental assignment method, while one selected control class uses common used inquiry conventional learning.

The population of this study was students of class XII taken from one of the high school in Jember. The study sample taken was 2 from 6 class XII, namely class XII MIPA A as an experimental class and class XII MIPA B as a control class, which was determined by *purposive random sampling.* Research data collection was done by using the method of observation, interviews, documentation, and tests. The thinking ability test was measured using the rubric of critical thinking obtained from the article Zubaidah, *et al.,* (2015). Then put into the criteria of critical thinking.

Tabel 1. Criteria for critical thinking

Criteria	Score
Obscured or still underdeveloped	0-2,9
Begin to develop or well-developed	3-5

Source: Kurniawati, *et al.,* (2015).

Critical thinking skills in this study were assessed based on the results of *pre-test* and *post-test* individually. The Analysis data used for critical thinking skills was anacova test to determine the effect of PBL learning models with experimental methods on critical thinking skills between the experimental and the control class. The analysis was assisted by using *SPSS 16.0 for Windows.*

3. RESULTS AND DISCUSSION

The results of critical thinking can be seen from the mean results, before being analyzed using covariate analysis (ANACOVA). Here is a table of mean results from students' critical thinking skills:

Table 2. Mean Difference of Critical Thinking Ability

Mean	Experiment class	Control class
Pre-Test	44	39
Post-Test	75	63
Difference	31	24

The table above shows that the average difference in student's critical thinking skills in the experimental class increased by 31, meanwhile the control class 24. This shows that the *problem- based learning* model with the experimental assignment method is able to further improve students' critical thinking skills in the experimental class than in the control class that uses the conventional-inquiry learning model.

Strengthened the previously results of the covariate analysis, the normality and homogeneity tests were also been performed.

Table 3. Normality Test Value for Critical Thinking Ability

Sig.	*Pre-test* Experiments	*Post-Test* Experiment	*Pre-test* Control	*Post-Test* Control
	0,396	0,613	0,330	0,381

The normality test result from the critical thinking skills pre-test and post-test value can be seen from the table above that shows the significance value > 0.05. This shows that the data from the two classes were normally distributed, H0 is accepted and H1 is rejected. Once it was known that the data is normally distributed, it can proceed to the homogeneity test that aims observe whether the data are the same (homogeneous) or different, so that if the data is homogeneous then it can be continued to covariate analysis.

Table 4. Homogeneity Test Results of Critical Thinking Ability Values.

	Levene Statistics	df1	df2	Sig
Pre-test	0,001	1	60	0,977
Post-test	0,215	1	60	0,645

The homogeneity test results show that the obtained significance was 0.489, means that H_0 is accepted and H_1 is rejected. This shows that the value of both classes is homogeneous.

Table 5. Covariance Analysis Test Results of Studensts' Critical Thinking Ability based on Pre-Test and Post-Test Values.

Sources	Number of quadrate type III	Df	Mean of quadrate	F	Sig
Corrected models	2259, 229a	2	1129,614	17,419	0,000
Intercept	14813,759	1	14813,759	228,429	0,000
Pretest	215,100	1	215,100	3,317	0,074
Class	1637,818	1	1637,818	25,225	0,000
Error	3826,190	59	64,851		

a.R Quadrate = ,371 (R Corrected quadrate = 350)

The results of the covariate analysis from the critical thinking skills also support previous statement with that the significance value of 0,000 <0.05. This indicates that H_0 was rejected and H_1 accepted, this mean that PBL learning model with the method of the experimental task successfully improves students' critical thinking skills.

Similar with the results of study conducted by Apriana and Anwar (2014) that PBL learning models are able to develop and improve critical thinking skills significantly. This is because PBL is a learning model that uses contextual problems in learning (Hartati and Solihin, 2015). Through solving these problems, students can actively build knowledge in groups so that they can accommodate the development of critical thinking skills (Wulandari, *et al*, 2011). Rahman, *et al*., (2018) also argues that solving given problems by formed learning groups were able to optimize students' critical thinking skills.

Ramalisa (2013) argues that students' thinking skills need to be trained. Practicing how to thinking critically on someone will make some habit. The earlier of these habits are instilled, the more a person has the potential to become a reliable critical thinker (Rahman, *et al*., 2018). Students in the experimental class are better trained to think critically because they use the PBL learning model. The process in PBL model focuses on the problems that exist in the student's daily activities, so students can be able to think critically by solving problems commonly encountered in their daily life (Rahmawati, 2018).

The PBL model used in this study was combined with the experimental assignment method so it had more significant influence in improving the critical thinking skills. According to Ennis and

Fisher, the indicators of critical thinking include analyzing, making hypotheses, considering alternatives, generalizing data, stating reasons, making conclusions, and applying concepts (Gumilar, *et al.*, 2019). According to Nugrahaeni, *et al*, (2017), the experimental method is able to fulfill those indicators of critical thinking, because the experimental method can direct students to apply concepts from studied theory, make hypotheses, observe an object, analyze, and draw final conclusions. The experimental method also fits the characteristics of the PBL model presented by Lestari, *et al*, (2015), in which students are able to produce some products / works and present them as well as cooperation among them.

The results of the study also emphasized by Julianto, *et al*, (2018), which explains that students are more active in the PBL learning process with the ability to observe, interpret, predict, and apply the concepts. Murlin, *et al.,* (2017), believes that the experimental method can be an effective method of learning to provide opportunities for students to be directly active and able to improve students' critical thinking skills. Mulyani, (2015) added that the experimental method proved to be able to give concentration as an emphasis on critical thinking skills. In accordance with this research, that the experimental method is carried out as a homework assignment, meaning the teacher asks students to carry out experimental activities at home. This is as stated by Marliani, (2015), that by giving student a take-home assignment it will increase the delivered material in the classroom. So the teacher can practice the students 'long-term critical thinking skills at school, and train the students' critical thinking skills at home because the steps in the experiment method effectively provide students to think critically.

The student's critical thinking ability was influenced by several factors including, excitement of objects seen by the eye will be directly processed in the brain so as to stimulate students' thinking ability. The discussion forum factor also make some influences, as students are confronted with the opinions of their classmates so they are trained on how to defend their opinions and how they can express their opinions (Sochibin, *et al.* , 2009). These factors cause the experimental class to have higher critical thinking skills because the stimuli from objects seen directly from the experimental task method process will be directly processed in the brain so that it stimulates students' thinking ability, compared to the control class. The experimental class is also having higher critical thinking skills because the discussion forum in the classroom leads students to learn how to defend and express their opinions, compared to the control class which only classical discussion and class presentation. That factor makes the mean difference in the ability to think critically between control and experiment class.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, it can be concluded that the *Problem- Based Learning* (PBL) model with the experimental assignment method has a significant effect on the critical thinking skills of student from class XII MIPA Senior High School in Jember, between the experimental class and the control class with a significance of (sig = 0,000) and mean differences of 31 (experimental class) and 24 (control class).

For further research, the results of this study were expected to be considered for further research activities with a variety of subjects, strategies, media, and other approaches so that students are more interested and can develop research, especially in educational research.

ACKNOWLEDGEMENT

Acknowledgments were addressed to the school that has given permission and opportunity for researchers to conduct and complete this study. Second, it is also addressed to lecturers who give plenty of help and guide for the completion of this study.

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