The effect of TPS and PBL learning models to the analytical ability of students in biology classroom

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Contents

Abstract

Analytical thinking is the competency needed by students in order to compete and achieve success in the professional field for the 21st Century. Research that aims to examine the most optimal learning model in empowering students' analytical thinking needs to be done since many students have low ordered thinking skills. Through this quasi-experimental research design, differences in achievement of analytical thinking between students who attended TPS and PBL learning were

reviewed. The study was conducted from April to June 2016, involving students of XI Science Class at the SSHS 13 of Banjarmasin, South Kalimantan Province-Indonesia. The data from the study were analyzed using ANCOVA test at a significance level of 5%. The findings suggested that PBL was able to empower a significantly higher analytical thinking than that of TPS. Thus, implementing PBL in a variety of biology learning is recommended as an alternative strategy to improve the ability of analytical thinking of high school students, especially in Indonesia.

Introduction

Biology is one branch of science that has become a compulsory subject since high school. Although it has several concepts that are considered difficult to learn (Çimer, 2012; Etobro&Fabinu, 2017; Fauzi&Fariantika, 2018; Ozcan, Ozgur, Kat, & Elgun, 2014), biology is still regarded as one of the favorite subjects (Fomichova & Misonou, 2018; Iqbal, Shahzad, & Sohail, 2010). Besides being widely liked by students, biology is also an important lesson because biological concepts are closely related to various aspects of human life (Reece et al., 2011; Rose, 2013). In fact, due to its significant and wider development that affect various joints of life, several references state that at present, human civilization is in the era of biology (Rose, 2013). Therefore, the quality of biology learning often determines the development and competitiveness of a nation in the current era (Ahmad, Abubakar, &Yau, 2018; Araoye, 2016).

The quality of biology learning can be evaluated and improved through various methods, one of which is through research activities (Elken & Wollscheid, 2016; Lodico, Spaulding, & Voegtle, 2010; Somekh & Zeichner, 2009). Various research activities with numbers of designs and data analysis have been carried out in the education field, including biology education (Fauzi & Pradipta, 2018; Goktas et al., 2012; Gul & Sozbilir, 2016; Karadag, 2010; Uzunboylu & Asiksoy, 2014). Some studies are more focused on evaluating conditions that describe biology education without the existence of interventions from the researchers (Alebaikan & Troudi, 2010; Fauzi & Ramadani, 2017; Ramdiah, Abidinsyah, Royani, & Husamah, 2019). Some other studies attempt to provide recommendations for learning that can be used to improve the quality of the learning process (Hassard, 2011; Srisawasdi, 2012; Thompson, 2017). In addition, other studies also develop products that are reported to be able to improve the quality of student's biology learning (Mehdipour & Zerehkafi, 2013; Rozkosz & Wiorogoska, 2016; Suciati & Adian, 2018; Widiansyah, Indriwati, Munzil, & Fauzi, 2018).

Through various reported studies, with the learning designs and the use of appropriate learning technology, biology learning is not only able to improve mastery of students' concepts but also able to empower various student competencies (Alebaikan & Troudi, 2010; Alonso, Lopez, Manrique, & Vines, 2008; Khalil & Elkhider, 2016; Ojo, Art, Ntshoe, & State, 2017). Some studies report that biology learning is able to improve students' thinking skills, such as critical (Boleng, Lumowa, Palenewen, & Corebima, 2017; Wilson, 2017), creative (Nurhamidah, Masykuri, & Dwiastuti, 2018; Sandika & Fitrihidajati, 2018), and metacognitive thinking skills (Fauzi, 2013; Husamah, 2015). Thus, biology learning is learning that has a great potential in empowering the competencies needed in the 21stCentury.

Unfortunately, the description of the potential and benefits of biology education that is able to empower the 21st Century competence is still not optimally reflected in Indonesia. This condition is caused by some teachers in Indonesia who still have not designed the learning optimally (Ramdiah et al., 2019). This phenomenon directs the level of high-ordered thinking skills of Indonesian students still in a relatively low rank (Santika, Purwianingsih, & Nuraeni, 2018; Sugiyanto, Masykuri, & Muzzazinah, 2018). In fact, these various thinking skills are needed by Indonesian students to face human resource competition in the 21stCentury. One of the required skills is analytical thinking.

Analytical thinking is an ability that involves critical thinking and problem-solving skills to find solutions or accomplish certain tasks (Donald, 2012; Robbins, 2011). Increasing analytical thinking skills is an important endeavor as this condition influences a person's success in the current era of science and technology (Kayali & Yilmaz, 2017). In addition, analytical thinking is a highly required competency in every aspect of a profession (OECD, 2002; Ratnaningsih, 2013). Analytical thinking is needed when situations are ambiguous and require individuals to be able to identify or solve the immediate existing problems (Robbins, 2011). Unfortunately, most teachers have difficulty in empowering students' analytical thinking skills (Freed & Pena, 2001). In fact, thinking skills can be improved through practice and habituation, through a proper conditioning design (Chinedu & Olabiyi, 2015). Therefore, the learning design that is able to familiarize students with training in analytical thinking has the potential to be able to improve these skills. Habitual activities can be done through the activity of answering high-ordered thinking questions, solving problems, and discussing answers to certain questions or problems.

Cooperative learning is a form of learning that facilitates students to discuss and exchange opinions on topics that are being studied (Ferguson-Patrick, 2018; Gillies, 2016; Lavasani, Afzali, & Afzali, 2011). In addition, a variety of cooperative learning is reported to be able to empower various high-ordered thinking skills of students (Hasan, Tumbel, & Corebima, 2013; Husamah & Pantiwati, 2014; Johnson

& Johnson, 2014; Setiawati & Corebima, 2017). Among others, Think Pair Share (TPS) and Problem based Learning (PBL) are two examples of cooperative learning that are often assessed for their benefits in learning. Previous research has reported the benefits of applying TPS to a variety of student thinking skills (Ngozi, 2009), while several other reports also address the benefits of applying PBL to various competencies (Bertacchini De Oliveira et al., 2016; Ramdiah, 2017; Sastrawati, Rusdi, &Syamsurizal, 2011; Talat & Chaudhry, 2014; Yaqinuddin, 2013). However, studies that examine the effect of applying TPS or PBL on students' analytic abilities are still difficult to find, especially in Indonesia.

A study on different levels of students' analytical thinking that is accustomed to TPS and PBL in Indonesia needs to be done urgently. Through this kind of assessment, information on the usefulness of applying these two learning models is increasingly widespread among educators in Indonesia. In addition, the findings obtained will be used as a reference for teachers in determining the design of learning that they will conduct.

Research Method

This research was a quasi-experimental study conducted from April to June 2016, involving students of XI Science Class at State Senior High School (SSHS) 13 of Banjarmasin as the study population. In total, there were four classes of XI Science in this school with the ability of students in biology learning between one class and another was at the same level. Therefore, a simple random sampling technique was exemplified in the selection of the samples. The XI Science 1 and the XI Science 3 classes were chosen as the samples of this study. The number of students in class XI Science 1 was 24, and the number of students in XI Science 3 was also 24 with a range of ages from 16 to 17 years old. The independent variable of this study was the learning model where students of XI Science 1 class received the PBL learning, while students of XI Science 3 class were treated with the TPS learning. The PBL syntax applied in this study was: 1) Orienting students to the problem; 2) Organizing students to learn 3) Guiding individual and group investigations, 4). Developing and presenting the work. 5). Analyzing and evaluating the problem-solving process. On the other hand, the syntax of TPS applied in this study was: 1) Thinking, 2) Pairing, and 3) Sharing. The research was conducted on the coordination system material, which consists of three subtopics, namely the nerve system, sensory system and hormonal system.

The dependent variable of this study was students' analytical thinking. The students' analytical thinking was measured using a test instrument consisting of ten essay items.

The question of the essay consists of questions with cognitive levels of C3 to C5. The scoring of students' answers implemented a rubric that referred to Hart instruments with a score scale of 0 to 4. Before being used as a research instrument, the essay questions were tested first. Question trial data were analyzed using the Pearson's Product-Moment Correlation test to determine the validity of each item and the Cronbach's alpha test to determine the instrument's reliability. The results of the analysis of the items inform that all items were valid and the question instrument had a reliability value of 0.712 so that the instrument was categorized as reliable.

The test instruments were used at the beginning and at the end of the study. The collected data were then analyzed using a one-way analysis of covariance (ANCOVA) test. Before the ANCOVA test was carried out, the data were analyzed for normality and homogeneity. The Shapiro-Wilk test was selected as a normality test, while the Levene test was used to measure the data homogeneity. In addition, a linearity test between pretest and posttest data was also conducted. If these assumptions were met, the data would still be analyzed using ANCOVA, but if the data did not meet the prerequisites, then the data analysis was transferred to the nonparametric test. The nonparametric test chosen in this study was the Quade's rank analysis of covariance test. The level of significance of this research data analysis was 5%.

Results and Discussion

Analytical thinking is a thinking skill that is significant to be empowered during the learning process. The selection of the suited learning model will certainly optimize the empowerment of skills needed in this 21st Century. The difference in the analytical thinking mean score between students who received PBL learning and TPS is presented in Figure 1.

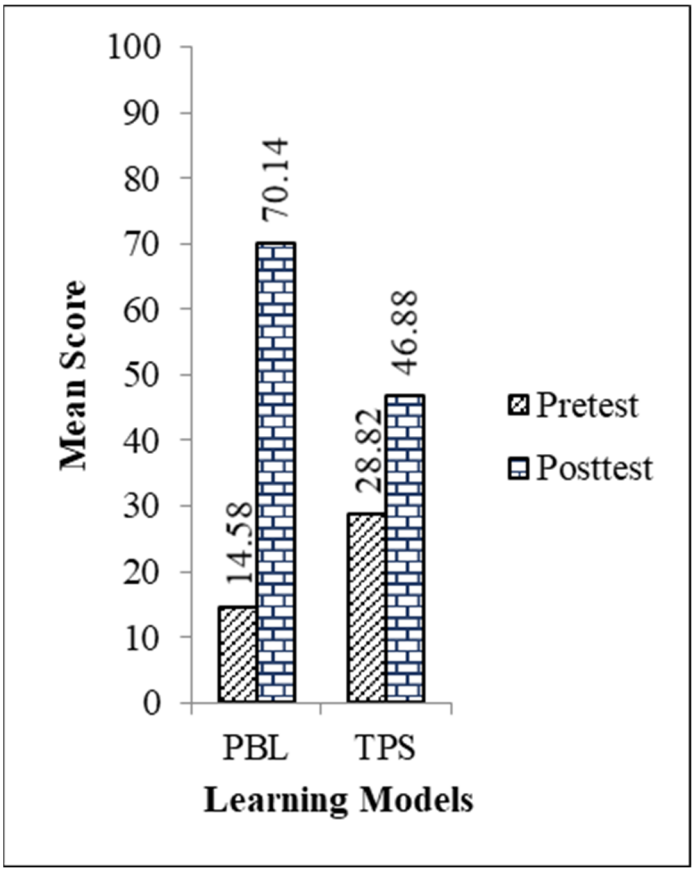

Figure 1. Comparison of pretest and posttest mean scores for analytical thinking between students who received PBL and TPS.

Based on Figure 1, students' analytical thinking was identified to experience improvement, both in the classes applying PBL and TPS. In this regard, there were no previous reports that examine the effect of these two learning models on improving students' analytical thinking. However, the application of PBL has been reported to be able to improve critical thinking skills (Masek &Yamin, 2011; Nazir & Zabit, 2010; Ramdiah, 2017) and student problem-solving skills (Jonassen, 2011; Kadir, Abdullah, Anthony, Salleh, & Kamarulzaman, 2016). Furthermore, the application of TPS was also reported to be able to empower students' thinking skills (Ngozi, 2009), although the frequency was not as much as PBL. Both critical thinking skills and problem-solving skills are two skills that are closely related to students' analytical thinking (Donald, 2012; Robbins, 2011).

Furthermore, based on the prerequisite test results, the data of this study were normally distributed ($p = 0.61$), had homogeneous variance ($p = 0.351$), and there was linearity between pretest and posttest ($p = 0.001$). Thus, the data can be analyzed using the ANCOVA test. Based on the ANCOVA test results presented in Table 1, it can be seen that the calculated F was 50.859 with $p < 0.05$. The results of the hypothesis test informed that the analytical thinking between students who received

PBL learning model and those of TPS learning model had significant differences. The corrected mean of students in the PBL class was greater than students in the TPS class (Table 2.). Therefore, the application of PBL in biology learning is proven able to significantly empower students' analytical thinking compared to the application of TPS.

Table 1. The Summary of ANCOVA test results on the influence of PBL and TPS implementation towards students' analytical thinking skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6565.709[a]	2	3282.854	39.095	.000
Intercept	16826.805	1	16826.805	200.386	.000
Pretest	71.749	1	71.749	.854	.360
Kelas	4270.739	1	4270.739	50.859	.000
Error	3778.735	45	83.972		
Total	174651.056	48			
Corrected Total	10344.444	47			
a. R Squared = .635 (Adjusted R Squared = .618)					

Table 2. The corrected mean scores of students' analytical thinking skills in PBL and TPS classes

Classes	Pretest	Postest	Differences	Improvement	Corrected mean scores
PBL	14.584	70.138	55.554	380.92%	71.249
TPS	28.819	46.875	18.056	62.65%	45.765

In the class that received TPS learning, students had the opportunity to practice their analytical thinking on several learning activities. At the 'think' stage, students were trained to answer the questions given by the teacher individually. The habit of answering questions has encouraged students to get used to practicing their thinking skills (Caroselli, 2009; Napp, 2017; Rashid & Qaisar, 2016). Next, at the 'pair' stage, students discussed the answers to their questions with their partners. The activity also facilitates students to think which answer is the most appropriate. Such learning activities are also able to empower students' thinking skills. Therefore, TPS learning is deemed able to empower students' analytical thinking, even though the empowerment is still not as optimal as PBL.

The high empowerment rate of PBL learning to boost students' analytical thinking in this study is relevant to several previous studies that compare PBL and other learning designs. Some reviewed the influence of PBL and conventional learning toward students' thinking skills (EL-Shaer & Gaber, 2014; Jackson, 2016; Sada, Mohd,

Adnan, & Yusri, 2016; Tiwari, Lai, So, & Yuen, 2008). Furthermore, several other types of researchreported that PBL has given a more positive influence compared to those of the other cooperative learning designs, such as jigsaw (Aisyah & Ridlo, 2015; Kustanti, Soegiyanto, & Rintayati, 2017), and guided inquiry (Yanti & Prahmana, 2017).

The class with PBL treatment gives more opportunity for students to habitually solve problems given by the teacher at the beginning of the class session. In each meeting, students will receive a problem and they are asked to provide ample solutions for the problem. The learning that habituates students with facing and solving problems is proven effective to empower students' thinking skills in general and analytical thinking in particular (Belecina & Ocampo, 2018; Cabanilla-Pedro, Acob-Navales, & Josue, 2004).

In addition, PBL's learning process helps students to shape their thinking framework and their analytical thinking pattern to solve problems faced in every situation. In the first phase, students start to analyze the problem provided by the teacher. In the second phase, students, facilitated by the teacher, define and organize the learning task. In the next phase, students are encouraged to collect information and do the experiment in order to solve the problem they will encounter during the development of the learning task. For this stage, students should be able to analyze the most suited information for problem-solving. Furthermore, students are directed to present their problem-solving discussed in their group. The presentation activity facilitates students to analyze and evaluate solutions delivered by different groups and determine which solution works better. Lastly, students are also guided to analyze and evaluate the problem-solving process that has been conducted.

From the PBL's string of activities above, the biology learning conducted in this study is able to guide students to conclude the findings from the data collection process and from the experiment they have done. It also chatters enough time to present students' findings in front of their friends. As the result, these learning activities are proven capable to train students' skills in solving various problems through scientific approach (Jensen, 2015; Krishnan, Gabb, & Vale, 2011; Masek & Yamin, 2011). This finding is in line with the statement from Akcay (2009) and Marra, Jonassen, and Palmer 2014), explaining that PBL is one learning model boosting the students' capability to build their own knowledge through investigation.

PBL guarantees the activeness of students in the learning process. This is supported by Etherington (2011) who explains that PBL positions students as the learning component who should be actively involved in the learning stages. If students are passive, the material absorbance, as well as the thinking skill empowerment will not succeed optimally (Freeman et al., 2014; R. Drake, 2012).

Conclusion

In this study, the influence of TPS and PBL toward students' analytical thinking skill empowerment was observed. The study results proclaimed that PBL was proven more effective in empowering students' analytical thinking compared to TPS. A string of learning activities conducted by the students in PBL class was able to empower their analytical thinking optimally.

Through this finding, the implementation of PBL in various other schools in Indonesia is highly recommended. Workshop to widely spread PBL needs to be implemented to familiarize the teachers of biology subject to PBL. Further study that investigates the empowerment level of PBL and other learning models should be promoted since the findings will certainly provide information on the advantage and disadvantage of PBL compared to other learning models. A study that observes the influence of PBL towards other thinking skills should be conducted as well in order for the teachers to know the advantage of implementing PBL in their learning process.

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