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Research Article

Improving student learning outcomes in science subjects through the implementation of PBL-based module

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ABSTRACT

PBL is a one of the learning model which has been reported can improve student learning outcomes optimally. Unfortunately, the frequency of implementing PBL and the teacher knowledge level about PBL is not optimal yet. This quantitative descriptive study aimed at determining the effect of PBL-based modules implementation on student learning outcomes. The population of this study was the XI grade students of SMAN 2 Wera in which the sample was the students of XI-Natural Science Class. Test was chosen as an instrument in the data collection process which was given at the beginning and the end of the implementation. The dependent-test was performed, after collecting the data. The study results indicated that the student learning outcomes increased significantly. Therefore, the application of PBL-based module is recommended to be carried out during science learning of XI graders.

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INTRODUCTION

Teaching science to students is a challenging and complicated process (Fleischner et al., 2017; Kadbey, Dickson, & McMinn, 2015; Omorogbe & Ewansiha, 2013). The reason is that science is considered a cluster of difficult (Buah & Akuffo, 2017; Etobro & Fabinu, 2017) and boring subjects (Shirazi, 2017). Besides, teachers must be aware that science learning often involves the fundamental knowledge that has been brought by students (Arends, 2012). This fundamental knowledge can sometimes help students understand science, sometimes also causing science misconceptions (Barke, Hazari, & Yitbarek, 2009; Fleischner et al., 2017; Karpudewan, Zain, & Chandrasegaran, 2017). Furthermore, science learning is also required to associate content with the daily lives of students (Asrizal, Amran, Ananda, & Festiyed, 2017; Suryawati & Osman, 2018).

Apart from the various challenges that have been mentioned, mastery of science by students is a significant factor in future national development (Fleischner et al., 2017; Kola, 2013).

Implementation of cooperative learning based on constructivism is a recommended step taken by science teachers (Ajaja, 2013; Ajaja & Eravwoke, 2010; Arends, 2012; Dogra, 2010; Rahayu, 2017; Slavin, 2014). Cooperative learning will help teachers optimize limited learning time. In addition, cooperative learning can overcome students' boredom because it can maintain their learning motivation (Alfares, 2017; Lai, 2011). On the other hand, the principle of constructivism will facilitate the teacher to associate science concepts that will be studied by students with the scientific concepts that students have brought before entering class (Shaaruddin & Mohamad, 2017). The application of constructivism learning can also minimize misconceptions in science learning (Putrayasa, 2018; Tompo, Ahmad, & Muris, 2016). One of cooperative learning with constructivism approach is problem-based Learning (PBL).

PBL has been adopted in various processes of education and learning (Yew & Goh, 2016) because of its enormous benefits. PBL is considered as one of the most effective learning models (Mustaffa & Ismail, 2015). Various references also inform many positive results of implementing PBL in science learning. PBL is informed of being able to improve concepts mastery, both junior high school (Zakariya, Ibrahim, & Adisa, 2016), senior high school (Yulianti, 2017), and college students (Zhang et al., 2015). Some studies also report that the application of PBL is also able to empower various students' thinking skills, such as critical (El-Shaer & Gaber, 2014; Ulger, 2018), creative (Sihaloho, Sahyar, & Ginting, 2017; Ulger, 2018), metacognitive (Adnan & Bahri, 2018), and problem-solving thinking skills (Jonassen, 2011).

PBL is not only seen as a learning model but also as an instructional approach that facilitates students to associate the concepts being studied with real situations. In PBL, the situation in real life is positioned as a problem that must be solved by students (Akcay, 2009). Through the problem-solving process, students will try to construct their scientific concepts. Therefore, PBL is considered as a learning model that supports the realization of meaningful learning.

As cooperative learning, PBL directs students to work in groups (Gorghiu, Drăghicescu, Cristea, Petrescu, & Gorghiu, 2015; Savery, 2006). The group work process will facilitate each group member to discuss their thoughts. They will learn to communicate and learn to work together to achieve the same target. In addition, the demand for heterogeneous groupings as a cooperative principle will help teachers overcome students whose abilities are below average (Arends, 2012; Zamani, 2016). The existence of smart students in each group will encourage other students to participate motivated in completing their assignments.

Unfortunately, even though it has been reported to provide various benefits in the learning process, the application of PBL in Indonesia is still not optimal. Various teachers in several schools still prefer to apply conventional learning (Kurniati & Surya, 2017; Zulfikar, 2013). One of the causes of this condition is the lack of understanding of science teachers on PBL. Some teachers do not understand the syntax of PBL and some others are not able to implement PBL syntax into the learning plan that they compile. Therefore, the availability of learning resources that can encourage students to learn independently with the principle of PBL is the leading solution to this problem.

One of the recommended learning resources in science learning is the module. A module must be used as teaching material instead of the educator's function. The characteristic of this teaching material has a structured and contains a set of planned learning experiences and is designed to help students' master specific learning goals. The learning module includes a set of activities aimed at facilitating students to achieve learning objectives. Modules are considered as innovative learning resources because they can facilitate students to learn independently. Not surprisingly, various studies report the positive impact of the existence of modules on the learning process (Serrat et al., 2014; Tiantong & Teemuangsai, 2013). Several development studies have also developed various modules which are expected to be able to improve students' academic achievements (Bahri, Syamsuri, & Mahanal, 2016; Huda & Arsana, 2013).

If referring to various previous studies, many studies have examined PBL. Some studies examined the implementation of PBL for thinking skills (Birgili, 2015; Nazir & Zabit, 2010; Eldy &Sulaiman, 2014), some others more focus on students' motivation (Argaw, Haile, Ayalew, & Kuma, 2017; Pelawi & Sinulingga, 2016). Some other researchers were more trying to integrating PBL with other learning models (Hou, 2014) or technology (Karami, Karami, & Attaran, 2013), while others prefer modifying this learning model (Burgess, Roberts, Ayton, & Mellis, 2018; Hudec et al., 2009; Liceaga, Ballard, & Skura, 2011). However, research that attempts to package PBL in the module form is still rare. The proof is that such modules were still challenging to find in various schools. This kind of research is urgent, given the rare application of PBL in schools due to the inability of teachers to design learning that applies PBL. The existence of such modules will help teachers apply PBL in the learning they hold. Therefore, the purpose of this study was to examine the effectiveness of PBL-based modules in science learning.

METHOD

This qualitative descriptive study was conducted at SSHS 2 of Wera, Bima, West Nusa Tenggara. The population in this study were all students of class XI, while students of class XI natural science were selected as samples. This research was conducted in the even semester of the academic year 2015-2016. Three stages in this research are preliminary data collection, PBL-based module implementation, and final data collection. PBL syntax is integrated into the module as in Table 1.

Table 1. PBL-module based syntax

PBL syntax	Modul	Description
Orientation the problem	Discourse	Giving an overview to the students about the problems to be learned
Organize the students	Organizing	Helping the students in analyzing the problems in the module
Group or independent investigation	Investigation	The students are asked to investigate through science work
Developing and presenting the work	Developing and presenting	Developing their works after doing the laboratory work
Analysis and problem solving	Analysing and problem-solving	write about the obstacles in conducting investigations

The variables used as determinants of module effectiveness were students' cognitive learning outcomes. The test instrument was used as a data collection tool in this study. The test instrument consisted of 15 multiple-choice questions. All items have been declared valid, and the test instrument is also declared reliable. All the items also meet the criteria both in the parameters of the difficulty level and the different items. After the data is collected, the data analysis was carried out. Descriptive analysis is used to obtain the average and gain a score of learning outcomes, while the dependent t-test is used to analyze differences before and after the application of the module. Before the t-test is conducted, the Kolmogorov-Smirnov test is used to ensure normality of the data.

RESULTS AND DISCUSSION

The results of students' pretest and posttest data are used as a basis for analysis to identify whether there are differences in learning outcomes using PBL-based modules. Results of the descriptive analysis, as shown in Table 2, shows an average difference between the pretest and posttest with an N-gain score of 0.74.

Table 2. Results of descriptive analyze and N-gain calculations

Test	Mean	Standard deviation	N-gain
Pretest	39.167	10.307	0.74
Posttest	83.917	6.071	

The N-gain score in Table 2 indicates a significant difference between the pretest and posttest averages so that an inferential statistical test is necessary. The dependent t-test analyze (Table 3) showed that between pretest ($M = 39.167$, $SD = 10.307$) and posttest ($M = 83.917$, $SD = 6.071$) had a significant difference [$t(23) = 25.848$, $p < 0.05$]. Furthermore, the implementation of PBL-based modules can improve learning outcomes of SSHS 2 of Wera students.

Table 3. Dependent t-test result

Pair	t value	Sig.
Pretest-Posttest	25.848	< 0.05

The results of this study reinforce some previous research which states that the integration of module-based PBL in learning can improve student learning outcomes (Gorghiu et al., 2015; Miharja, Syamsuri, & Saptasari, 2015). The implementation carried out steadily and consistently is proven to be able to improve students' critical thinking skills (El-Shaer & Gaber, 2014; Zabit, 2010). Problems that are used as learning resources become triggers that respond to students' thinking skills (Jonassen, 2011; Sada, Mohd, Adnan, & Yusri, 2016). Thus, students become conditioned to be able to literate various completion hypotheses (Jonassen, 2011; Klucevsek & Brungard, 2016). The existence of collaborative efforts in a learning group enriches the hypothesis so that students can see the problem from a different perspective (Iversen, Pedersen, Krogh, & Jensen, 2015; McCrum, 2017; Serevina, Sunaryo, Raihanati, Astra, & Sari, 2018).

On the other hand, the characteristics of the learning modules that emphasize independent learning activities according to some researchers provide maximum learning space for students (Leow & Neo, 2014; Maryani, Martaningsih, & Bhakti, 2017; Serrat et al., 2014). This statement refers to research Rufii (2015); Waluyo, Prayitno, and Sugiyarto (2017), which states that students who learn to use modules can think constructively. The completeness of features in a module based on PBL, according to some researchers, provides a logical picture to students in solving problems or understanding a phenomenon, including making observations (Belecina & Ocampo, 2018), analyzing (Setiyadi, Ismail, & Gani, 2017), making hypotheses (Ergul et al., 2011; Jiun & Nurzatulshima, 2014), conducting investigations (Argaw et al., 2017; Zabit, 2010), and making conclusions (Ravitz, 2009).

Besides, the characteristics of science learning that study a problem or phenomenon, by some researchers, are considered appropriate when done with the PBL model (Lewinsohn et al., 2014; Serevina et al., 2018; Siswati & Corebima, 2017). However, the teacher needs to analyze the accuracy of the media and the learning strategies that are appropriate for discussing a particular material (Ismail, Harun, Zakaria, & Salleh, 2017; McCrum, 2017). These analyze is essential because the material presented with the right media and strategies can maximize student learning potential (Gay, Mills, & Airasian, 2012; Miri, David, & Uri, 2007). In this case, the selection of PBL-based modules used in the learning process is considered to meet these elements, indicated by an increase in value from pretest to posttest.

The results of this study certainly need to be continued with further research, such as the analysis of students' critical thinking skills. However, an increase in learning outcomes is a positive indicator of the implementation of PBL-based modules in learning. Furthermore, this study recommends the use of PBL-based modules in learning, especially science learning.

CONCLUSION

Implementation of learning by using PBL-based modules can optimize student learning abilities so that it has an impact on improving learning outcomes, seen from differences in achievements before and after using the module.

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