Florea: Jurnal Biologi dan Pembelajarannya
Vol. 11, No. 1, May 2024, pp. 7~14
ISSN 2355-6102; e-ISSN 2502-0404 DOI: 10.25273/florea.v11i1.21091

How can LS Improve the Effectiveness of PBL-TaRL in Biology Learning with Ecosystem Material?

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Article Info

Article history:

Received February 20, 2024
Revised March 25, 2024
Accepted May 31,2024

Keywords:

TaRL
PBL-TaRL
LS (Lesson Study)
Ecosystem material

ABSTRACT

The main objective of this research is to analyze the effectiveness of PBL-TaRL implementation through Lesson Study (LS) on Ecosystem material in high school. The research design used a combination of qualitative and quantitative data through mixed methods with triangulation. The study consisted of three cycles that observed students' learning activities especially in the Plan, Do, and See stages. A pretest-posttest sheet in the form of a google form and an observation sheet were used as instruments in this study. All data were analyzed qualitatively with paired sample t-test and N-Gain test. The results showed that LS-based PBL-TaRL had effective results in learning, from the acquisition of N-Gain in cycle 1 of 72.2%, 95.75% in cycle 2, and 89.66% in cycle 3. These findings are expected to provide information for subject teachers, and the government in the field of education to further develop and apply the PBL-TaRL approach.

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1. INTRODUCTION

The current Indonesian education system has undergone a curriculum transformation or what we know as the Merdeka Curriculum. This curriculum offers teachers the flexibility to teach according to the capacity or ability of the students or not based on grade level, which is recognized as Teaching at the Right Level (TaRL) [1];[2];[3];[4];[6]. The TaRL approach in the Merdeka Curriculum is an effort to achieve learning objectives and minimize problems between students in one class and overcome lag in learning. [6];[4];[3]. The implementation of the TaRL approach has an outline that the teacher must identify based on the learning level of students, grouping according to the same ability or level, then the teacher can deliver learning according to groups at the same level of student ability. At the end of the learning stage, teachers can conduct an assessment to identify the level of student achievement after applying the TaRL approach. The application of the TaRL approach has been carried out [7], which states that the application of learning with TaRL obtained significant results.

The implementation of Merdeka Curriculum in the classroom also recommends the use of a problem-based learning (PBL) model. Through this model, teachers can provide apperception in the form of problems that come from the environment around students. The use of PBL model is suitable for Biology subject because the problems presented are based on issues or topics that exist in the surrounding environment [8]. This PBL learning model consists of several syntax, which are:

(1) defining the issue, (2) orienting students to learn, (3) leading the investigation, (4) constructing and presenting results, (5) examining and evaluating the problem-solving process [9]. PBL learning model is an effective model in creating student-centered learning and improving critical thinking skills [10];[11]. This is supported by Surya, et al. (2014) stated that problems designed and solved using the PBL learning model can improve critical thinking skills. In line with that study, the PBL learning model integrated with TaRL can increase students' interest in learning biology [13] improve students' communication skills [14] and achievement in writing skills [15].

PBL-TaRL can be done collegially by a team of teachers within the Lesson Study (LS) framework. LS is implemented collaboratively with peers or a team consisting of teachers and observers [16]. The LS framework includes plan-do-see activities [17] and conducted periodically [18]. Some study reveals that the implementation of LS contributes to helping improve learning. This statement is reinforced by Lukitasari (2019) which reveals that LS activities are one of the optimal efforts that can be made to observe the process or activities of students in better learning. In addition, research by Wahyuni, Susetyarini, & Latifa (2015) stated that the application of LS integrated with various learning models was able to increase critical thinking skills in Biology subjects. Moreover, implementation LS also has an impact on improving pedagogical competence, science skills of teachers [20];[21], and professional development of teachers [22].

The data from classroom observations conducted at SMAN 1 Nglames in May 2023 through interviews with class teachers found that students' scores in Biology subjects, including on ecosystem material, about half of the students in the class were under the Minimum Completion Criteria (KKM). This lack of achievement is caused by the difficulty of students understanding Biology lessons, one of which is ecosystem material. Ecosystem materials are characterized by organisms and objects in an environmental system. The concepts in this material are often book-based and not based on contextual issues or problems. According to Subiantoro, Ariyanti, & Sulistyo (2013), contextual aspects need to be presented in environmental problems to realize real problems and to take a stand in solving these problems. This underlies the need for the application of contextual learning to form a problem- solving mindset in students. Therefore, the application of PBL-TaRL is one of the strategies in presenting a real context for students in learning.

Considering the above explanation, this study needs to be conducted because the analysis of PBL-TaRL in the LS framework implementation has not been known in depth, especially in Biology subjects with Ecosystem material. Furthermore, the main objective of this study is to analyze the effectiveness of PBL-TaRL implementation in accordance with the LS framework on ecosystem material.

2. METHOD

This study presents a type of mixed methods with triangulation between qualitative and quantitative data. The implementation of LS was conducted three cycle with plan, do and see [16]. The subject of this research was one class of tenth grade students of SMAN 1 Nglames which amounted 29 students and the LS-based PBL-TaRL learning model was conducted in the class.

The data were analyzed qualitatively using paired sample t-test and N-Gain test. Paired sample t-test was used to compare means and to obtain significant results by assuming that the data were normally distributed first. The N-Gain test was used to analyze the effectiveness of PBL-TaRL in LS implementation by interpreting into the effectiveness criteria shown in Table1. The N-Gain value was obtained by the following formula.

$$\text{N-Gain Score} = \frac{Score\ posttest - score\ pretest}{Score\ \ ideal - score\ \ pretest}$$

Table 1. Criteria for effectiveness of the N-Gain Score results based on the research of Hake, R.R. (1999)

Percentage (%)	Interpretation
< 40	Ineffective
40 - 55	Less Effective
56 - 75	Effective Enough
>75	Effective

The learning topic in this study was Ecosystems, conducted in three LS cycles during the even semester of the 2022/2023 academic year. Learning process is performed according to the PBL-TaRL syntax based on the LS framework. The cycles of the LS presents in following Figure 1.

ISSN 2355-6102; e-ISSN 2502-0404

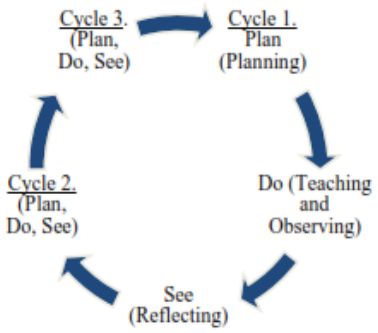

Figure 1. The Cycle of Implementation LS

The entire LS process in each cycle begins with the development of PBL-TaRL based lesson plans by the team who have a background in Biology education for the three implementation cycles. The LS framework starts from the Plan stage. At this stage, lesson plans and student worksheets were discussed with experienced Biology teachers who also acted as observers. At Do stage, learning activities are executed in accordance with the the planning stage. In the See stage, researchers and observers collaborate to evaluate the series of learning processes that have been implemented. This research emphasizes the importance of prior observation and formative assessment results to determine and identify students' learning readiness, designing learning and reflecting on good practices that can be done through LS.

The results of the pretest-posttest and documentation were used as data collection methods. Pretest-posttest sheet in the form of google form and observation sheet were used as instruments in this study. Lesson study data were obtained from observation sheet by the observer (O) and the results of students' response (SR) at the end of the lesson. Test data collection (pretest-posttest) is used to measure academic progress. Worksheets are organized and distributed based on the ability level of the student groups. This is followed by the presentation of results, with groups from higher and lower levels making presentations based on the results that have been discussed.

3. RESULT AND DISCUSSION

This study consisted of three cycles and each cycle was based on the LS framework, which are plan, do and see. At the plan stage, researchers have designed teaching modules and worksheets for each meeting. Teaching modules are prepared using a PBL learning model that is adjusted to each material. The material in cycle-1 is about ecosystem components, in the cycle-2 is energy flows in ecosystems, and in the cycle-3 is the interaction between components. The result of the implementation is described in Table 2 as follows.

Table 2. Lesson Study-based PBL-TaRL implementation results

Plan	Do	See
Ecosystem components	During learning in cycle-1, students were separated into 8 groups with 4 members, categorized into lower and higher groups. In the upper group, students were asked to analyze the biotic and abiotic components of the marine ecosystem and their roles. While in the lower group, students analyzed the biotic and abiotic components in the agricultural ecosystem.	Reflections from the first cycle showed that group division was still unfamiliar to the students. However, during the teaching and learning process, students pay enough attention to the material presented, and the teacher is able to condition the class when students start to get bored and less focused. On the other hand, students tended to be inactive in answering questions, and seemed hesitant in delivering explanations.
Energy flows in ecosystems	Cycle 2 was conducted based on the results of the first cycle reflection. The student worksheets were differentiated based on higher and lower groups. In the higher group, students worked on food web material and related questions. While in the lower group, students worked on food chain material and questions related to food chains.	Students already seem to follow the process of learning. Some students from the lower group were active in discussing with their group mates. While students in the higher group are more active by expressing their opinions. The teacher invites students to do ice-breaking, which is interesting.

Interaction between components	The implementation of Do in cycle 3 was implemented based on the findings obtained in cycle 2. In cycle 3 the higher group worked on the biogeochemical cycle, while the lower group worked on the interaction between components.	Students are getting familiar with their learning groups. Both lower and higher groups have shown their participation in learning which can be seen from their participation in discussions and giving opinions. This approach with TaRL is able to facilitate differentiated learning. In further learning, the lower group can be upgraded to the higher group based on their improvement.

The learning stages begin with making lesson plan, preparing worksheets in accordance with the group level of students, as well as conditioning students into groups according to ability level (TaRL). Apperception is presented in the form of pictures and videos related to the material, at this stage students pay attention and analyze the apperception presented by the teacher. Before entering the next stage, the teacher conducts a pretest to measure students' initial abilities. At the core of learning, the teacher presents problems for higher and lower groups to be analyzed with their group members. The implementation of PBL-TaRL based on LS followed by quantitative data aims to test the effectiveness of the treatment using paired sample t-test and N-Gain test. The data is declared normally distributed so that it can be continued with a paired sample t-test. The results of the paired sample t-test analysis are presented in Table 3 below.

Table 3. Paired Sample t-test

Paired Samples Test									
Paired Differences									
				95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest - Posttest	- 42.759	21.387	2.293	-47.317	-38.200	- 18.648	86	.000

Table 3 presents the data of paired sample t-test with the result (2-tailed) of 0.000 means that the value is smaller than <0.05. From the data obtained showed a significant difference in the implementation of PBL-TaRL in the learning that has been done. The data is supported by the results of pretest-posttest measurements in each cycle presented in Figure 2.

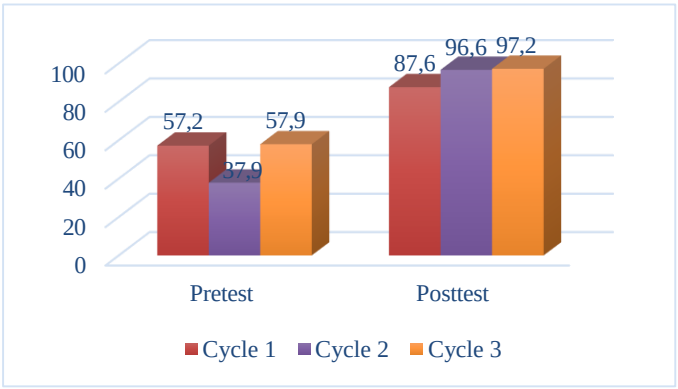

Figure 2. The average of pretest-posttest score based on LS

Figure 2 explains that in cycle-1, the pretest average was 57.2 and the posttest average was 87.6. These results indicate an increase in pretest-posttest. In cycle-2, the pretest-posttest increased from 37.9 to 96.6. While in cycle-3, the pretest-posttest increase was obtained from an average of 57.9 to 97.2. Figure 2 shows the pretest-posttest improvement in each cycle. In addition, the effectiveness of PBL-TaRL in each cycle can be seen from the N-Gain percentage presented in Figure 3.

ISSN 2355-6102; e-ISSN 2502-0404

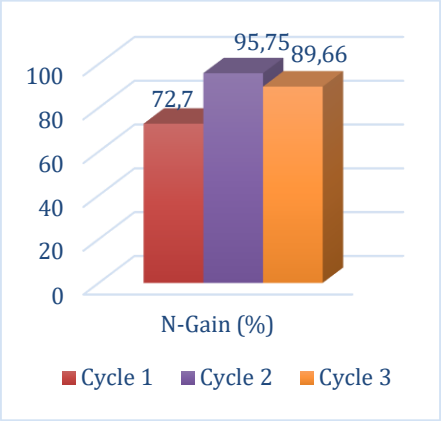

Figure 3. N-Gain scores percentage based on LS

Figure 3 shows the effectiveness of PBL-TaRL implementation with N-Gain percentage results of 72.7%, 95.75%, and 89.66%. The LS framework starts from the planning stage. The planning stage is carried out to analyze various problems in learning and the needs required, such as the learning models and approaches used, learner activities, learning media, and learning ecosystems that support the learning process. At the Do stage, the teacher carries out the learning with the Biology teacher as the observer. At this stage, the observer's job is to observing student learning activities and taking notes on any student responses to learning activities as well as activities that are not in accordance with the lesson plan [23]. Therefore, the observer should be familiar with the stages of learning and the use of instruments in observation[24].

From the implementation stage, it can be seen to what extent the effect of PBL-TaRL implementation has been carried out through the assessment results. Then the learning begins with the teacher conditioning the class and doing apperception. The class was divided into 8 groups consist of 4 students in the lower group and 4 students in the upper group. After Plan and Do are applied, the next stage is reflection (See). Observers provide reflection and evaluation at this stage. The reflection and evaluation state a positive response to the significant involvement of students in learning that has been done by applying PBL-TaRL. In this reflection session, the observer stated below.

The implementation of PBL-TaRL is effective enough in improving the quality of learning. We could see from the students activeness, especially in XE of SMAN 1 Nglames. This approach is also a step in the demands of current curriculum for differentiation learning. The application of PBL-TaRL is supposed to improve students' comprehension and ability according to their level. (O-1)

PBL-TaRL based on LS provides a new experience for researchers. In addition, the participation of students in learning activities can also be seen from the activeness of students from both lower and higher levels. This is in line with Korompot et al. (2020) who stated that the high interest of students in learning is shown by their active participation. There was a positive response from students to the implementation of PBL-TaRL from the reflection results at the end of the lesson. This is reflected in their comments.

I have enjoy this learning and the discussion session compared to the usual group, because in this group my friends and I participated actively in the group discussion. (SR- 1)

During the implementation of PBL-TaRL based on the LS framework, it was observed that the learning was conducive and there were visible results of students' participation at the lower level. By giving worksheets according to the students' ability level, it provides a new atmosphere in learning and as an effort to improve learning. Some difficulties were felt at the beginning of the activity process, such as grouping students, determining the material into lower and higher levels, and adjusting students to the new groups formed. However, as LS is conducted, improvements can be made to overcome these obstacles.

Some points obtained as a result of the reflection discussion in the first cycle such as group conditioning which is still unfamiliar to students, however in cycle 1 students pay enough attention to learning well as evidenced by the increase in pretest-posttest. The teacher was able to condition the class when students began to get bored and less focused. Although in cycle-1, students tended to be less active in asking questions, and tended to be hesitant in delivering explanations. This obstacle is an evaluation material for researchers to find solutions to increase and stimulate students' interest in learning further. However, PBL-TaRL learning supports students, especially in lower groups to

actively discuss. This is supported by the effectiveness of N-Gain of 72.7% (Figure 3.) with the interpretation in Table 1. which shows effective enough.

In addition, questions from students related to the material during learning have appeared. This is in line with the increased of pretest-posttest average of 37.9 – 96.6. N-Gain value was 95.75% indicates >75% with a result effective interpretation. Based on the results of reflection on cycle 2, a positive response to learning by students was obtained which was shown through the reflection presented in the google form sheet. The following are the results of students' reflections on the lower level:

The learning is fun, I am able to understand the teaching material, but I am not yet familiar with my group. (SR- 2) I found it easy to understand the material, but it took some habituation for me with the new group. (SR- 3) I like this group, because we all work in discussion. (SR- 4)

In cycle-3 it could be observed that the group process went better, students could easily adjust and get organized compared to the previous cycles. The increase in pretest-posttest results was 57.9 to 97.2 and the effectiveness rate was 89.66% (Figure 3). This is because students are accustomed to the grouping that is done. In addition, the teacher provided support such as explanations of materials or student worksheets, especially for groups of lower level students.

Throughout the class process, students participate in group discussions divided into their learning levels. Learners' abilities are diverse because they come from various backgrounds, such as culture, economy, learning needs, physical health, emotional, mental readiness, and readiness to learn [26];[27];[28]. One of the steps in making learning more meaningful is by grouping students according to their ability or level. As a study by Yuli, Utomo, & Sukoco (2023) revealed that grouping in TaRL makes it easier for teachers to guide students in each category more intensely. Learning according to ability will also increase students' motivation to learn so as to make themselves a true learner. Someone who is motivated to learn will enjoy facing challenges, be creative, thoughtful and try to find solutions [4]. They share ideas and give feedback to each other. Lesson plans and worksheets have been developed and implemented according to the needs of each student. This approach enables students to receive an increase achievement from pretest and posttest results. Cahyono's (2022) explained that the implementation of TaRL could improve students' learning outcomes.

4. CONCLUSION

PBL-TaRL based on LS has effective results in learning, from the acquisition of N-Gain in cycle 1 of 72.2%, 95.75% in cycle 2, and 89.66% in cycle 3. Researchers see that students who are classified based on their ability level will experience an increase in understanding of the material in each pretest and posttest. When students in the *lower level* group have shown signs of improvement, they can be grouped into the next level or *higher* level. Due to the limited time owned by the researcher, so that the grouping students from lower to higher levels is not possible. Another limitation is the habituation in grouping according to ability levels that are still rarely used.

RECOMMENDATION

The implementation of PBL-TaRL has an effective impact on students and teachers. According to the results of this research, some recommendations that can be suggested are: (1) continue and expand the implementation of research in other fields or materials; (2) continue research on the achievement of students' cognitive and psychomotor domains; (3) implementation for a longer duration of time to see the level of improvement students have at each level.

ACKNOWLEDGMENT

This research project was supported by Ministry of Education of The Republic of Indonesia with Pendidikan Profesi Guru Prajabatan at Universitas PGRI Madiun FY 2023–2024.

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