International Social Sciences and Humanities
UMJember Proceeding Series (2023) Vol. 2 No 2: 386-393

(KOPI) 2023

Improving Collaboration and Cognitive Learning Outcomes of Biology Students using PBL through Lesson Study

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DOI: https://doi.org/10.32528/issh.v2i2.268
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Published: Mei, 2023

Abstract: Collaboration is one of the essential 21st-century skills and can have an impact on learning outcomes. The application of PBL is expected to train collaboration and improve students' cognitive learning outcomes. The research aimed to discover the increase in collaboration and cognitive biology learning outcomes of students using PBL through Lesson Study. This type of research uses classroom-based action research. The research subjects were students at SMA Negeri 3 Jember class X5, the academic year 2022/2023, totaling 35 students. The implementation phase of classroom-based action research is carried out through Lesson Study. The results show that applying PBL through Lesson Study can improve collaboration and students' cognitive biology learning outcomes. Increased student collaboration is evidenced by an average score of 64 (cycle 1), 75 (cycle 2), and 92 (cycle 3), while student cognitive learning outcomes are evidenced by an average value of 71 (cycle 1), 78 (cycle 2), and 86 (cycle 3). The findings of this study can be a solution for educators to apply PBL through Lesson Study as an alternative to improve collaboration and students' cognitive biology learning outcomes.

Keywords: Collaboration; Cognitive Learning Outcomes; Biology; PBL; Lesson Study

INTRODUCTION

Biology is learning that emphasizes students' experiences and interactions with living things in everyday life (Wegner & Schmiedebach, 2020). The aim of learning biology is to equip students with concepts that are easy to understand and apply in their lives. This biology lesson also trains students to increase their sense of responsibility in managing nature and dealing with changes that occur in society (Supiandi & Ege, 2017). Biology is still a subject that is difficult for students to understand, for example, when describing some living things, such as microorganisms or those related to some biological events or processes (Erbas & Demirer, 2019). Students' difficulties in studying biology are caused by several things, including inappropriate learning strategies, inadequate learning resources, and ineffective student learning habits (Etobro & Fabinu, 2017). Therefore, students' difficulties in learning biology are an important problem that teachers need to solve so that biology is easy for students to understand.

Biology learning needs to be understood by students because it discusses various sciences that can be applied to solve human problems, such as health problems, agriculture, required fields and others (Fauzi & Mitalistiani, 2028). Biology is one of the subjects that contribute to developing students' 21st-century skills (Cahya et al., 2022). The 21st-century skills, namely 4C consisting of: Critical thinking, Creativity, Communication, and Collaboration, are essential skills that students must have (Khoiri et al., 2021).

Collaboration is one of the essential skills of the 21st century, which is currently included in the character of the Pancasila Student Profile, namely cooperation. Cooperation skills emphasize student collaboration competencies for teamwork (Brata et al., 2022). According to (Badan Standar Kurikulum dan Asesmen Pendidikan, 2022), the Pancasila Student Profile on the cooperation dimension, namely collaboration, includes several sub-elements, including cooperation, communication to achieve common goals, positive interdependence, and social coordination. In fact, according to the results of research (Le et al., 2018) it shows

that students' collaboration abilities are low. Low collaboration is seen when they participate less in group problem-solving task discussions. According to (Nahar et al., 2022), low student collaboration skills are also marked by the need for student ability to make group learning, lack of sharing opinions, having closed thoughts, difficulty in sharing group roles and responsibilities, and low motivation and enthusiasm for student learning.

The results of observations and interviews with biology teachers at SMAN 3 Jember in November showed that students' collaboration skills in learning biology still needed to improve. It is due to low student learning motivation, students are still embarrassed to ask questions or express difficulties they experience during education, and students do not participate in group discussion activities. Students also think biology is a subject with broad content, is abstract and memorizes a lot, making it difficult to understand. According to (Hadiprayitno et al., 2019), students with difficulty learning biology concepts will affect their enthusiasm and cognitive learning outcomes.

Cognitive Learning Outcomes (CLO) are measurable results of students' intellectual effort towards various learning process activities that have been carried out (Shi et al., 2021). Based on the test of biology learning outcomes given in class X SMAN 3 Jember, as many as 53% of students still have cognitive learning outcomes below the KKM, namely 76. According to research (Jufrida et al., 2019), students' low cognitive learning outcomes of students are caused by students lack of understanding of biology concepts. Students are also not used to being trained to solve biology problems. Hence, students need help solving the questions given. These difficulties have an impact on low CLO.

Students' low collaboration skills and CLO still need to be improved. Student collaboration skills in biology learning are essential because it trains students to work together, discuss, tutor each other, and be able to make decisions on problems encountered in education. Good student collaboration will make it easier for them to achieve learning goals effectively, so it has a good impact on learning outcomes (Supena et al., 2021). Improving learning outcomes, especially in the cognitive domain, is essential because it relates to understanding the concepts or principles of biology that have been studied (Nasir et al., 2019). CLO can be improved by training students to actively participate in collaborative work or peer tutoring during learning activities (Ullah et al., 2018). Therefore, to overcome the low collaboration skills and CLO, biology learning needs to use effective learning models and integrate biology concepts into students' real lives.

One appropriate learning model to use is Problem-Based Learning (PBL). PBL is a student-centred learning model. The stages of the PBL model include orientation to problems; organizing to study; guiding investigations; developing and presenting works; analyze and evaluating the problem-solving process (Arends, 2015). The research (Aslan, 2021) results show that the application of PBL affects problem-solving skills, communication, student interaction, and learning achievement. Applying PBL can facilitate collaborative learning and encourage students to acquire material in depth. Research (Miterianifa et al., 2019) also proves that PBL can develop students' thinking skills, train students to solve complex problems, collaborate in groups, communicate skills, and hone students' cognitive abilities. Therefore, the application of PBL in biology learning has the potential to improve collaboration skills and CLO of students.

Teachers implementing biology learning certainly face various problems in class. Problems can come from students because students have different characteristics. Besides that, they can also come from class conditions. Therefore, to overcome issues in learning, teachers need to apply Lesson Study (LS). In implementing LS, an LS team will be formed to facilitate collaboration between novice and experienced teachers (Coenders & Verhoef, 2019). Lesson study (LS) helps improve the quality of teacher learning processes and patterns (Vermunt et al., 2019). LS can facilitate teachers to learn from each other with fellow teachers or students. Teachers can also observe each other, discuss the practice of learning activities with each other, and give and receive feedback on the practices that have been carried out. LS activities in teaching practice, especially using the PBL model, must continue to be carried out to improve the quality of learning. Thus, applying the PBL model is expected to enhance students' collaboration skills and cognitive learning outcomes in biology learning. Therefore, this study aims to determine the increase in collaboration and CLO of students using PBL through lesson study.

METHOD

This type of research is Classroom-Based Action Research. The implementation stage of classroom-based action research is carried out with Lesson Study, which includes: Plan, Do, and See. The research was conducted in November-January, odd and even semester, 2022/2023 academic year, at SMAN 3 Jember, Jember Regency, East Java, Indonesia. The research subjects were 35 students of class X5. The treatment instruments included teaching modules, teaching materials, learning media, and LKPD (Student Activity Sheets). The instrument used is collaborative assessment and posttest assessment to measure students' CLO. In the student collaboration assessment category, if a score of ≤ 20 is obtained, it means that it is inferior, $21 \leq x \leq 40$ is lacking, $41 \leq x \leq 60$ is sufficient, $61 \leq x \leq 80$ is good, and $81 \leq x \leq 100$ is perfect (Sabon et al., 2022). In the category of assessment of students' cognitive learning outcomes, if a value of ≤ 54 is obtained, it means that it is inferior, $55 \leq x \leq 59$ is lacking, $60 \leq x \leq 75$ is sufficient, $76 \leq x \leq 85$ is good, and $86 \leq x \leq 100$ is perfect (Cahyaningtyas et al., 2020).

The implementation of the PBL model in learning activities uses stages: student orientation to problems, organizing students for learning, guiding individual and group investigations, developing and presenting work, as well as analyzing and evaluating problem-solving processes (Arends, 2015). The teaching practice was carried out in 3 cycles. Plan, Do, and See activities are carried out in each cycle. The stages of implementing LS in each cycle can be seen in Figure 1.

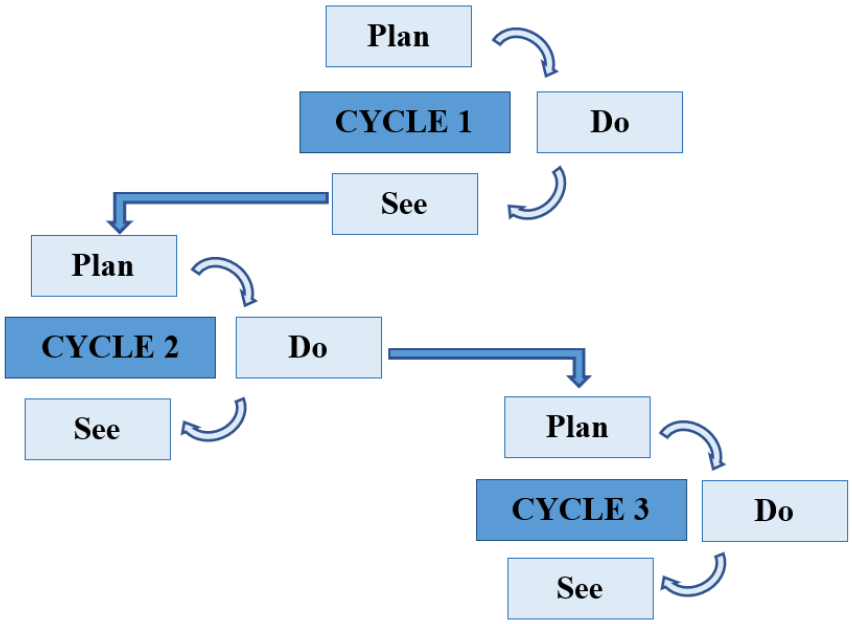

Figure 1. Stages of Lesson Study Implementation in Each Cycle

RESULTS AND DISCUSSION

By applying the PBL model through Lesson Study, biology learning activities get good responses from students. This response impacts improving collaboration skills and students' CLO from cycle 1 (C1), cycle 2 (C2), to cycle 3 (C3). In each learning activity, an assessment of collaboration and CLO is carried out on students. The results of the assessment are then classified based on predetermined value categories. The percentage of students who scored based on the collaboration assessment category and cognitive learning outcomes in each cycle can be seen in Table 1.

Table 1. Results Percentage of Number of Students based on Collaboration Assessment Category and Cognitive Learning Outcomes

Category	Collaboration			Cognitive Learning Outcomes		
	C1	C2	C3	C1	C2	C3
Very less	8,57%	8,57%	0,00%	20,00%	8,57%	2,86%
Not enough	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Enough	17,14%	2,86%	0,00%	34,29%	25,71%	37,14%
Good	37,14%	34,29%	17,14%	0,00%	0,00%	0,00%
Very good	37,14%	54,29%	82,86%	45,71%	65,71%	60,00%

Table 1 on the collaborative assessment shows that the percentage of students with good and very good scores increased from cycles 1 to 3. In the collaborative assessment in cycle 3, no more students scored very less, not enough, or enough. The assessment of cognitive learning outcomes based on Table 1, as a whole, shows that students who get very less scores decrease from cycles 1 to 3, while fair and very good scores increase from cycles 1 to 3, even though cycle 2 has a higher increase than cycle 3. Increasing the value of collaboration and students' CLO can also be seen from the average value obtained in each cycle. The results of the average value of collaboration and students' CLO can be seen in each cycle in Table 2.

Table 2. Results of the Average Value of Collaboration and Students' CLO in Each Cycle

Average Value of Collaboration			Average Value of CLO		
C1	C2	C3	C1	C2	C3
64	75	92	71	78	86

Table 2 shows that the mean value of collaboration and students' CLO is increasing from cycles 1 to 3. The most significant increase is in cycle 3, as evidenced by the average value of collaboration of 92, while the average value of CLO is 86. The increase in the mean value collaboration and student CLO in more detail can be seen in Figure 2.

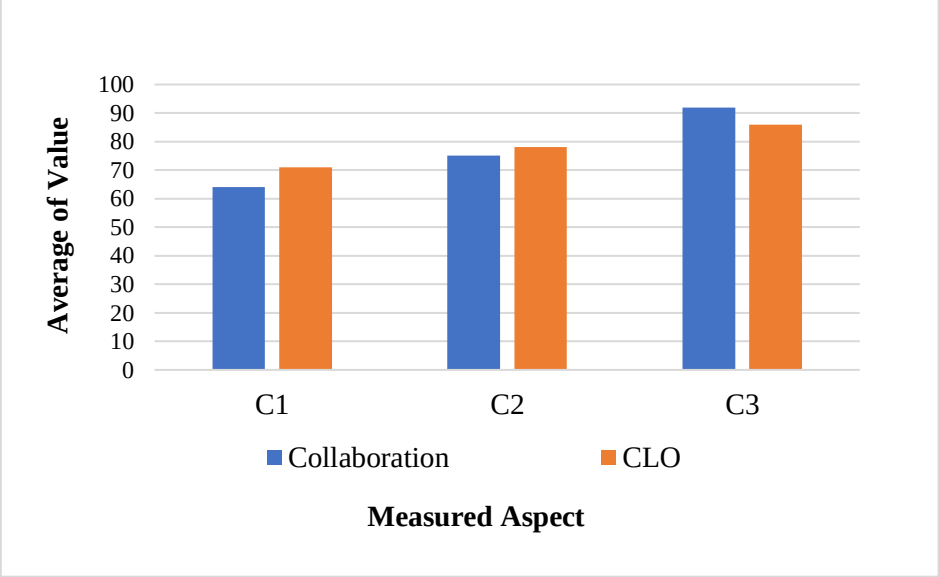

Figure 2. Increasing the Average Value of Collaboration and Students' CLO

Figure 2 shows that the collaboration skills and CLO of students in biology learning continued to increase from cycle 1 to cycle 3. The application of the PBL model influenced this increase through Lesson Study carried out during biology lessons in class. Students also respond differently to the learning activities carried out in each cycle.

In cycle 1, the researcher (as a model teacher) carried out the Plan with the LS team, supervising lecturers, tutor teachers and Teacher Professional Education (PPG) colleagues before learning activities in class. Plans are carried out to discuss learning tools (teaching modules, teaching materials, learning media, worksheets, and assessment instruments) used in learning activities. Do is carried out during class learning by applying learning tools that have been prepared based on suggestions and input according to Plan. The learning objective to be achieved during Do is to identify the role of viruses in global issues (Covid-19 and Hepatitis A) by examining articles regarding the parts of viruses that are beneficial and detrimental to the human body, when "Do" found several problems in learning.

The problems during Do in cycle 1 included: students still needed clarification in following the stages of learning activities using the PBL model. It is because students are participating in biology learning activities for the first time using the PBL model, which is integrated with the LKPD. The application of the PBL model is new for students because students are directly invited to understand each stage of PBL to solve problems in learning biology. Students need to know that the PBL stages impact their difficulties in finding issues and solutions related to learning objectives. Student involvement in group discussion activities still needs to improve. Some students still need to pay more attention when their friends carry out discussions and are less active in expressing opinions in discussion activities. It causes the work of LKPD to be hampered. Content differentiation, carried out according to the independent curriculum, could be more effective in helping students understand learning material. It is because students cannot share knowledge or learning experiences when they study different content in each group. The problems experienced during learning caused the time allocation to exceed the predetermined limit. Various issues faced by students and model teachers later became material for reflection in See's activities.

See activities in cycle 1 provide many solutions for model teachers. This solution becomes the basis for carrying out follow-up plans as an improvement to the learning that has been carried out. The follow-up plan will be to develop teaching modules that suit the characteristics of students or student learning styles. Teaching modules that are arranged need to emphasize process differentiation learning according to student learning styles. Student learning style data was obtained from the results of a diagnostic test conducted by the school. The reason for using process differentiation is that some students still need help understanding the problems or assignments given by the model teacher. In LKPD, the activities also need to be simplified so that the time allocation does not exceed the limit but contains activity steps that can increase student collaboration and achieve learning objectives that must be performed in the next cycle 2.

In cycle 2, the model teacher and the LS team did Plan. Plan activities aim to discuss learning tools and learning objectives that will be used in Do activities. The learning objective to be achieved is to observe conventional biological technology innovations in food (soy sauce) using their understanding. During Do, the problems faced by students during learning are decreasing. Students have started to understand the stages of the PBL model contained in the LKPD assignment. Students' understanding of the PBL model allows them to find problems and collaborate with group members to solve the issues and find solutions to their problems. Students working on LKPD can already cooperate with each other in groups, express opinions, share roles and responsibilities, and coordinate with each other to achieve common learning goals. It follows the statement [25] that PBL, supported by group activities, can train students' collaboration skills. This activity allows students to improve their problem-solving skills and acquire new knowledge to achieve common goals.

The successful implementation of Do in cycle 2 is inseparable from the application of differentiated learning processes used during learning activities using PBL. Process differentiation learning helps students to get study assistance according to student learning styles. Learning style data shows that out of 35 students, 55% have an auditory learning style, 29% have a kinesthetic learning style, and 16% are a visual one. Therefore, students are grouped homogeneously based on their learning styles. Groups of students with an auditory learning style are given a learning process using learning videos. Groups of students with a kinesthetic learning style are given a learning process through puzzle shopping activities.

In contrast, groups of students with a visual learning style are given a learning process by studying articles or looking at pictures. Providing study assistance according to student learning styles makes students collaborate with groups to understand learning material. It follows the statement (Marlina et al., 2022) that differentiated learning facilitates the student learning process according to student readiness, interests, and learning profiles. This differentiated learning positively impacts students' understanding of the material taught

by the teacher. Students become familiar with the principles of biotechnology in general, the principles of conventional and modern biotechnology, examples of traditional and modern biotechnology, and the easy process of making soy sauce. Students' understanding of the material has a positive influence on improving students' CLO. Thus, the learning activities carried out in cycle 2 have developed collaboration skills and CLO of students better than in cycle 1. The obstacles encountered during Do activities in cycle 2 have decreased, but some obstacles that still arise need to be material for reflection in activities See.

See activities in cycle 2 were implemented with the LS team by providing solutions and suggestions to model teachers to overcome obstacles that still arise during learning activities. The obstacle faced was that some students still needed to participate in group discussion activities actively. It is because students complain that they do not match the distribution of group members. Therefore, in the follow-up plan for the next learning activity in cycle 3, the model teacher needs to change the student group members. Changes in group members are expected to increase student collaboration for optimal learning.

In cycle 3, Plan is carried out with the LS team to discuss learning tools and objectives used during Do. The learning objectives to be achieved are identifying questions and problems in making soy sauce by looking at assumptions based on scientific research results. The obstacles faced by students when "Do" is decreasing. Students already understand the stages of learning using PBL. The first stage of PBL is problem orientation. In problem orientation, students and groups are assigned to understand and find problems through a learning process based on their learning style. Students with an auditory learning style carry out the learning process through learning videos. Students who have a visual learning style are given a learning process by studying articles. Students with a kinesthetic learning style carry out the learning process with puzzle shopping. These different learning processes are called process-differentiated learning. The application of differentiated learning makes students active, motivated, and happy to participate in learning activities. It is proven that differentiated learning can provide learning independence for students and create fun learning that influences student learning outcomes. Supported by the results of research (Yanzi et al., 2022) that differentiated learning can optimize students' needs and learning outcomes.

The second stage of PBL is organizing students to learn. Students in groups collaborate at this stage to define the problems found. Students are also trained to ask questions related to the issues to be investigated and explored. This activity can train students' thinking skills and train cognitive abilities. The third stage of PBL is guiding individual and group investigations. This stage can train students to collect various information to solve problems or find alternative solutions to the issues they face. Students can obtain information through the learning process and from various relevant learning sources. The fourth stage of PBL is developing and presenting the work. This stage invites students with their groups to convey the results of their discussions to the teacher and other students. This activity can train students' active involvement and responsibility in group assignments. It has a positive impact on students' collaboration skills. It is supported by the statement (Chen & Kuo, 2019) that the stages of PBL in learning activities can increase student activity and interaction in learning and produce collaborative study groups. Applying PBL can also develop students' communication skills, collaboration, teamwork, and problem-solving abilities (Deep et al., 2019). The final stage of PBL is analyzing and evaluating the problem-solving process. At this stage, students are asked to reflect and evaluate the results of discussions or learning activities that have been carried out. Some obstacles became material for discussion in the implementation of See with the LS team.

As a whole, the implementation of learning activities from cycle 1 to cycle 3 received increased positive responses from students. This positive response can be seen from the increase in students' collaboration skills and CLO in each cycle. The highest increase was in cycle 3. It proves that applying PBL through Lesson Study effectively increases collaboration and CLO of students. Thus, the findings in this study can be an alternative solution for teachers to improve collaboration and student learning outcomes.

CONCLUSION

Applying the PBL model through Lesson Study improves collaboration and students' cognitive biology learning outcomes. The increase in student collaboration is evident from the results of the average score in cycle 1 of 64, cycle 2 of 75, and cycle 3 of 92. The increase in student cognitive learning outcomes is evident from the average value of 71 in cycle 1, 78 in cycle 2, and 86 in cycle 3. Therefore, educators can apply PBL through Lesson Study as an alternative learning to develop collaboration skills and CLO of students in learning

biology. In future research, educators should be able to know the characteristics of students and pay more attention to students who have learning problems. Educators also need to pay attention to the allocation of time in each learning stage so that the implementation is more optimal.

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