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Developing Problem Based Learning through Lesson Study

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Abstract
Critical thinking skills are important to be empowered in the 21st century. Critical thinking skills are the ability to collect and evaluate information to draw the right conclusions. Educators need Lesson Study (LS) activities to empower students' critical thinking skills taught by Problem-based Learning (PBL). This research was conducted on 27 third-semester students at the State University of Malang in 2021 with the aim of improving students' critical thinking skills in learning plant physiology using PBL. Improvement of the learning process is carried out with LS activities. The LS implementation phase consists of plan, do and see. Lesson Study findings obtained focus on the duration of learning, controlling student interaction in study groups, contextual problems, and selecting essential learning topics. The results of the N-Gain test in the first cycle obtained a low category score of 0.14, while in the second cycle a medium category score of 0.38 was obtained. Students' critical thinking skills are empowered through drawing conclusions from data collection to solve contextual problems.

Keywords: Lesson Study, Problem-based Learning, Plant Physiology, Critical Thinking Skill

Introduction

The competition for life in the 21st century is getting higher (Wright et al., 2015), thus attracting attention for the improvement of the Indonesian education system (Zubaidah, 2016). The results of 21st century education focus on higher order thinking skills which consist of analysis, synthesis and evaluation (Osborne, 2013). One of the higher-order thinking ability is critical thinking skills (Zubaidah, 2016). Aspects of critical thinking skills according to Greenstein (2012) consist of application, analysis, using data to build critical insights, synthesis, and evaluation

Critical thinking skills can be used to find and evaluate information in order to produce the right conclusions to solve problems (Smith, 2012). Critical thinking skills can be used to sort out information so that it can be distinguished between fact and opinion, bias and truth, and logic and emotion (Duldt, 1994). Information that develops in the 21st century is so massive that a person needs critical thinking skills to be able to adapt flexibly (Dwyer et al., 2014). The 21st century also requires the ability to solve complex problems through critical thinking skills (McGrath & Torres, 2012). Empowerment of critical thinking skills in the learning process can help students respond in class learning, completing tasks, and manage learning time (Smith, 2012).

The application of critical thinking skills in the real world can be seen in forensic science and crime reconstruction by rejecting all conclusions without strong evidence, analysis, and interpretation skeptically (Chisum & Turvey, 2011). Aspects of critical thinking skills suitable for case solving, are analysis, synthesis and use data to build critical insights, as in Greenstein (2012), It is said that the analysis aspect can be assessed by the ability to identify the main problem, specify the steps in detail, and see the implications that are not stated, and understand complex ideas and various perspectives.. Aspects of synthesis can be assessed by identifying and comparing the components of an argument to produce a cohesive new summary, as well as skillfully linking the whole piece into one unit. While the aspect of using data to build critical insights can be assessed by using accurately selected data to draw conclusions that are in harmony with the facts.

Empowerment of critical thinking skills in learning, can be done with the use of learning models that are learners-centered and collaborative in order to solve problems (Sahoo & Mohammed, 2018).). Problem-based learning (PBL) models can improve critical thinking skills (Anazifa & Djukri, 2017). Critical thinking skills can be improved through the application of PBL, because learners are encouraged to get used to being active in the learning process, so that they unconsciously ask and answer, discuss with each other in groups, refute arguments in solving problems, collect data, and conclude learning outcomes (Erma et al., 2019).

Research conducted by Ates & Eryilmaz (2010) found that the difficulty of educators in implementing PBL, including the unfamiliarization of educators in applying PBL, so it requires careful planning to align learners with PBL. Another problem found, is the mastery of learning content by educators and they tend to convey their knowledge directly to learners so that it is not in accordance with the PBL process. Research by Tyas (2017) shows that the obstacle in aligning learners with PBL is the difficulty of finding the right problem, and it is difficult to manage the duration of learning every step because educators are still not used to aligning with PBL.

Improvement of the PBL learning process can be done with educator collaborative learning through Lesson Study (LS) activities to analyze the curriculum, and student needs, and can be useful to improve learners' learning outcomes, create an active student learning atmosphere, and foster the creativity of learners (Singerin et al., 2020). LS activities are carried out with educators in the field of subjects to solve learning problems (Norwich & Ylonen, 2015; Ono & Ferreira, 2010). Shared learning is done by reflecting the results of learning activities based on the experience they gained during the learning process (Inprasitha & Changsri, 2014; van Driel & Berry, 2012)

The application of PBL in Plant Physiology (Fistum) learning is very appropriate and in accordance with the context of problems in PBL that require other understanding outside the Fistum subject. As stated by Arends (2008) that the problem context in PBL is interdisciplinary, namely linking concepts from other lessons. The complexity of the Fistum material as stated by Adhani & Rupa (2020) that the Fistum cannot be understood properly if it has not been preceded by an understanding of the basic concepts of cells, anatomy and morphology of cells, plant tissues and organs, as well as biochemistry, and plant ecology.

Based on the background of the problem, this study aims to improve the Fistum learning process which is taught with the PBL learning model through LS activities, to improve students' critical thinking skills in the aspects of analysis, synthesis, and use of data to build critical insight.

Method

This type of research is a mix method, which aims to improve the PBL learning process through Lesson Study to improve students' critical thinking skills in the aspects of analysis, synthesis, and using data to build critical insight through PBL learning. The research was conducted at the State University of Malang in 2021. The sample used was 27 third semester students of the Department of Biology.

Qualitative data collection is done by observation and documentation, while quantitative data collection is done by giving tests of critical thinking skills. Observations and documentation were used to monitor the course of the PBL learning process, while tests were used to see the improvement of students' critical thinking skills between cycle one and cycle two.

The data collection of lesson study activities is carried out in three steps, namely plan, do and see, which can be seen in Table 1.

Table 1. Lesson Study Activities

No.	Lesson Study	Result
1	Plan	• Discussion in the learning communitieas • Create chapter design • Create lesson design
2	Do	• Learning by model lecturers in class according to lesson plans • Observation by observer
3	See	• Reflection on the model lecturers experience during the implementation of classroom learning • Observer reports • Improvement of the learning design based on the results of reflection and observation reports by observers

Critical thinking skills test is used to assess the improvement of students' critical thinking skills as a result of learning in cycle 1 and cycle 2. Indicators of critical thinking skills can be seen in Table 2.

Table 2. Indicators of Critical Thinking Skills

No	**Skills**	**Indicator**	**Score**
1	*Use data to develop critical insight*	• Using accurately selected data to draw conclusions that align with the facts	4
		• Demonstrate the use of data to draw conclusions and form insights	3
		• Tried but had difficulty selecting data and using it to draw conclusions	2
		• Unable to independently apply and use data in a meaningful way	1
2	*Analyze*	• Identify the main problem, specify the steps in detail, and see implications that are not stated. understand complex ideas and multiple perspectives	4
		• Identify and understand the main problem, but do not develop good problem solving ideas	3
		• Inaccurately describe the main problem. Unable to carefully listen to it objectively	2
		• With help can understand the immediate problem and draw simple conclusions	1
3	*Synthesize*	• Identify and compare argument components to produce a new, cohesive summary. Skilled at combining the parts into a single unit	4
		• Able to put two different ideas together, see patterns firsthand, and summarize them	3
		• Can see ideas related to one point of view and use them to generate summaries	2
		• Relationships between ideas are difficult to understand except at a basic level	1

(Source, Greeinstein, 2012; 200)

Qualitative data analysis was carried out in each cycle consisting of data reduction activities, data presentation and drawing conclusions referring to the interactive analysis model by Miles and Huberman. The data analysis process can be seen in Figure 1.

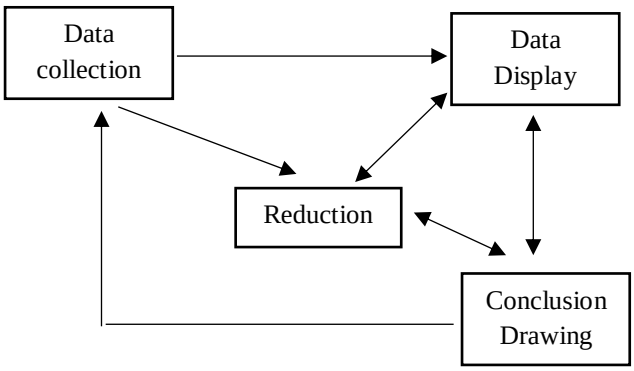

Figure 1. Interactive Analysis Cycle

Quantitative data analysis using N-Gain, to determine the category of critical thinking skills improvement in the application of PBL in each LS cycle. The category of learning improvement in the calculation of N-Gain can be seen in Table 3.

Table 3. Category of N-Gain Score

N-Gain Score	Category
<g> <0,30	low
0,30 ≤ < g> < 0,70	Medium
0,70 ≤ <g>	High

(Source Meltzer, 2022)

Results and Discussion

Learning activities were carried out in four meetings with 2 Lesson Study cycles. Lesson Study activities consist of three stages, namely Plan do and see as follows:

Cycle 1

The learning in cycle 1 was carried out by applying PBL on the topics of allocation, translocation and photoassimilate partitioning.

Plan

Planning activities are carried out by involving all LS team members. Planning activities are carried out to design chapter designs, lecture program units (SAP) and student worksheets (LKM). The design chapter that has been made contains three main sub-materials, namely translocation, allocation, and photoassimilate partitioning. The material in the design chapter is taught using the PBL learning model in a duration of 5 lesson hours. LKM contains problems related to the process of translocation of photo assimilate from source to sink through sieve elements of phloem vessel tissue.

Aspects of critical thinking skills that were developed at this meeting consisted of three aspects referring to the critical thinking skills rubric by Greeinstein (2012), namely the analysis related to the identification of the photoassimilate path that was translocated from sink to source in the sieve element, and what factors influenced the translocation. The second aspect is the synthesis by identifying and comparing the components of the argument in predicting the production of plant photoassimilate. The third aspect, is to use the data to build critical insights developed by evaluating experimental data to draw new conclusions about the storage of photoassimilates in sinks and source.

Do

The implementation stage is carried out by applying the results of the plans that have been made previously. The implementation of learning is carried out by the model lecturer and observed by the LS team. The observer team records events that occur in the learning process which will then be discussed in reflection activities.

See

The reflection stage, starting with the exposure of the model lecturer's experience in teaching PBL, was followed by providing input on the results of observations from the LS team. The reflection results obtained several improvements in plant physiology learning, namely students began to actively express their opinions when stimulated by simple questions on the topic of photoassimilate translocation, such as "give your opinion about the basic differences between translocation, allocation and partition?" or the question of "what is the basic reason, plants translocate photoassimilate products in the form of sucrose?".

The difficulties found during learning, namely students are less responsive in solving problems when working on the LKM. Students seem to need a bit of time before starting to formulate problems and hypotheses for problem solving. Another difficulty was found, namely the lack of authenticity of the problem in PBL, so that learning did not maximally indicate the achievement of PBL learning objectives. The problems that arise are only in the form of questions that can be answered by reading the literature, not problems as characteristic of PBL problems in Arends (2008), namely problems must be solved interdisciplinary.

The complex scope of plant physiology learning cannot be presented at once in the PBL problem solving process, so it will be linked in the strengthening process by the model lecturer. In cycle 1 learning, the new model lecturer adapts in implementing PBL learning so it is difficult to set the duration of the learning stages. The critical thinking skills of students who were taught with PBL in cycle one increased from pretest to posttest with scores in the low N-Gain category. The value of N-Gain cycle 1 can be seen in Table 4.

Table 4. Value of N-Gain Cycle 1

N-Gain	Category
0.14	Low

Cycle 2

Cycle 2 learning, carried out by applying PBL on the topic of growth, 1) growth development and hormone regulation; 2) photomorphogenesis and phytochrome; and 3) photoperiodism, flowering and fruit development. Each topic is taught with a focus on different aspects of critical thinking skills, namely analysis, synthesis and using data to build critical insights. LS cycle 2 activities are as follows.

Plan

Planning activities are carried out by applying the results of reflection in cycle 1. Planning activities begin with SAP improvement to clarify the activities of model lecturers and students as well as the time duration of each stage in the learning process, streamlining the design chapter to only cover essential material, and fixing problems in the LKM. Critical thinking skills in the analytical aspect were developed on the topic of Photoperiodism by analyzing plant characteristics based on their response to the photoperiod. The synthesis aspect was developed on the topic of growth, development and hormone regulation by integrating and comparing the mechanism of action of hormones synergistically and antagonistically to produce a new, cohesive understanding. The aspect of using data to build critical insights is developed by using data to draw conclusions about the performance of Pr and Pfr in regulating growth and development.

Do

The implementation of learning activities is carried out by applying PBL. Learning activities are carried out by model lecturers. At the implementation stage of cycle 2, the lecturer pays more attention to the duration of learning, and controlling student discussions in order to avoid the duration of learning that is too long because students do not understand the steps in PBL. The model lecturer occasionally asks questions to stimulate students' critical thinking in the process of collecting data for problem solving.

See

Reflecting on the second cycle, it was found that the progress of the learning process, especially in setting the duration of learning, the presentation of learning topics that covered almost all the material that had been planned, and the problems presented were adapted from the results of the research so that the problems were more contextual. The interaction of students began to increase by giving each other arguments in study groups. Minniti et al., (2017) say that PBL with contextual problem solving can encourage interaction between students. Students' critical thinking skills in cycle two increased from pretest to posttest with N-Gain scores in the medium category. The second cycle N-Gain value can be seen in Table 5.

Table 5. Value of N-Gain Cycle 2

N-Gain	Category
0.38	Medium

Critical thinking skills in learning plant physiology can be improved by applying the collaborative learning model in PBL (Mandusic & Blaskovic, 2015; Sahoo & Mohammed, 2018; Soller, 2001). Activities of collecting evidence, providing interpretations and drawing conclusions can improve critical thinking skills (Chisum & Turvey, 2011). Adhani & Rupa (2020) said that plant physiology is a complex study, and requires an understanding of other studies such as biochemistry, plant ecology, basic concepts of cells, cell morphology, and plant tissues and organs. Plant physiology courses that require other learning concepts in order to be studied well, are in accordance with the principle of problems in PBL as Arends (2008) said that problems in PBL must be interdisciplinary, namely combining understanding concepts from other learning, so that knowledge will be built broadly. and flexible because knowledge is not learned in the form of certain concepts (Hmelo-silver, 2004)

Conclusion

The learning process of plant physiology that is taught by applying PBL can be improved by collaborative learning between educators called Lesson Study. Improving the PBL learning process can improve students' critical thinking skills through data collection activities and contextual problem solving. The improvement of the PBL learning process found in this study focused on the duration of each learning step, controlling student interaction, contextual problems in PBL, and selecting essential learning topics.

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