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The Effect of Problem Based Learning (PBL) Model with Analyze Case Study on Respiration System Material on Students Critical Thinking Ability

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Abstract

The purpose of this study is to analyze the effect of PBL learning by analyzing case study material of the respiration system on students' critical thinking skills. The study was conducted Nonequivalent Control Group Design. The entire students of grade XI MIPA SMAN 15 Semarang on the academic year 2019/2020 was chosen as the population. The method in taking the sample was Purposive Sampling, XI MIPA 6 as the control class and XI MIPA 7 as the experimental class. Observation, questionnaire, test, and interview were methods that used in collecting the data. The result showed that student's learning critical thinking at 52% on the high category and at 48% on the middle category. Based on the result, it can be concluded that the learning using PBL with Analyze Case Study affects student's critical thinking ability on the respiratory system material.

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INTRODUCTION

The rapid development of science and technology has an impact on various fields, including education. Education must prepare qualified and highly competitive human resources to meet the needs of the 21st century (BSNP, 2012). Education has an important role in improving human resources. In an effort to improve the quality of education, the Indonesian government has made various improvements to the curriculum and collaborations with study institutions to evaluate the level of achievement of the curriculum and learning patterns. For example, Indonesia participated in the 2015 Trends in International Mathematics and Science Study (TIMSS) international survey, ranking 45 out of 48 countries in the field of science with a score of 397 (IEA, 2015). Research results from the Program for International Student Assessment (PISA) carried out by the Organization for Economic Co-operation and Development (OECD) in 2018 Indonesia has scientific skills ranked 70 out of 78 countries with a score of 396 (OECD, 2019).

Based on these results, the science skills of Indonesian students need to be improved. According to the OECD (2017) the PISA assessment aims to assess the quality of education to face human resource challenges in the 21st century. 21st century learning is developed with the aim of preparing students for the era of the global economy. Industry in the 21st century is engaged in creativity and innovation. According to the Pacific Policy Research Center (2010) to achieve success in the world of work in the 21st century requires skills that students must possess, including communication and collaboration skills; critical thinking and problem solving; creativity and innovation. On the other hand, the 2013 curriculum requires the formation of students who are critical, creative, and innovative (Rakhmawati et al., 2016). Students' critical thinking skills need to be improved in order to gain the competencies needed to succeed in subjects (Addy et al., 2014). Critical thinking skills can be improved by active learning that is student-centered and based on constructivism (Setiawati & Corebima, 2017). So far, most science education has not been oriented towards habituation and increasing critical thinking skills, but still focuses on cognitive learning outcomes (Kirmizi, 2015).

Based on the results of observations conducted at students experienced difficulties in learning the respiratory system material because there were many foreign terms that were difficult to understand and the material on the respiratory system had a broad scope. The learning method has been less attractive. Based on interviews with biology teachers, students have difficulty answered questions that require analysis and which have a high level of difficulty, and are difficult to relate things related to phenomena that occur around them with learning, are less enthusiastic to ask questions and have opinions when given the opportunity. Overall, it can be concluded that learning at schools in general has not sharpened students' critical thinking skills, has not been oriented towards students because it uses lecture and discussion methods. Learning that was applied still does not require students to be active and train thinking to find concepts independently. This method has not fully directed students to improve critical thinking skills.

As part of science, biology has different characteristics from other sciences. The objects studied in biology are living things and life problems. This certainly has an impact on the approaches and strategies applied (Mulyani et al., 2008). Regulation of the Minister of Education and Culture of the Republic of Indonesia number 103 of 2014 concerning Learning in Primary and Secondary Education which states that the implementation of the 2013 curriculum is highly recommended to use a scientific approach with discovery learning, inquiry learning, project-based learning, and problem-based learning models. PBL is designed in such a way that students discover concepts and principles independently and take an active role in learning to make students able to understand concepts well. PBL memiliki karakteristik menggunakan masalah yang tidak terstruktur. PBL has the characteristic of using unstructured problems. The problem used is a problem that is often encountered in everyday life (Chin & Chia, 2006).

In addition to the learning model, teaching and learning activities are accompanied by the Analyze Case Study learning strategy, which is a supporting strategy in presenting more specific problems in the PBL learning model which is classified as active learning and case-based learning. In this strategy, the teacher provides a clear and specific case to students, which then the students are asked to discuss and analyze the proposed case (Hosnan, 2014: 232). According to the biology teacher at the school, they have never applied the PBL learning model with Analyze Case Study.

PBL and Analyze Case Study strategy affects student's critical thinking abilities. Gholami et al., (2016) in their research concluded that PBL has an effect on critical thinking skills and metacognitive awareness by showing a statistically significant effect on the development of critical and metacognitive thinking skills. Isnanen et al., (2018) proved that PBL is suitable for use in learning that aims to improve critical thinking skills. Naude & Derera (2014) concluded that the use of case studies can deepen understanding of the material. Case discussions between students can be used to analyze, apply concepts, learn to solve problems, and improve communication skills. Arum & Minangwati (2014) concluded that learning with case studies can improve students' critical thinking skills and enthusiasm for learning.

The respiration system is one of the materials in learning biology class XI even semester which is quite complicated because of the wide coverage of the material and it uses many foreign terms. In the subject of the respiratory system, the core of the language can be directly observed and felt by students. This material is concrete in nature so that to understand the concept, students can make connections with things in everyday life. This is in line with the opinion of Ruggiero (2012) that teaching critical thinking will be easier if the content taught is related to factual things in everyday life.

Based on this background, the purpose of this study was to analyze the effect of PBL learning with Analyze Case Study on the respiratory system material on students' critical thinking skills.

RESEARCH METHODS

The research was conducted at SMAN 15 Semarang in even semester in the academic year of 2019/2020. This type of research is a Quasi-Experimental Design. The research design used is the Nonequivalent Control Group Design according to Sugiyono (2016) which includes the control and experimental groups not chosen randomly, but based on directions from the biology teacher. The experimental and control groups conducted a pretest to determine the description of students' critical thinking skills before learning. After that, the experimental class carried out PBL learning with Analyze Case Study, while the control class used discussion and lecture learning. Then the two samples carried out the students' critical thinking posttest.

The research steps include preliminary observations including potential and problem analysis, determining the subject as a sample, namely class XI MIPA 6 as the control class and XI MIPA 7 as the experimental class, making learning tools, compiling research instruments, conducting test questions in class XII MIPA 3, question trial analysis, research implementation, research data analysis, preparation of research results discussion. The data in this study included the results of students critical thinking tests, the results of student activity analysis, the implementation of PBL learning with Analyze Case Study, questionnaire analysis of student responses and descriptive analysis of teacher responses. The critical thinking test indicator in this study refers to (Ennis, 2016) which is to provide a simple explanation, building basic skills, concluding, provide further explanation, set strategy and tactics.

RESULTS AND DISCUSSION

The purpose of this study is to analyze the effect of PBL learning with Analyze Case Study on the respiratory system material to the students' critical thinking ability in learning. The effect of PBL learning with Analyze Case Study in the respiratory system material is measured from the achievement based on predetermined indicator, namely students' critical thinking ability reaches > 75% in the middle and or high category.

Critical Thinking Ability

Data on students' critical thinking abilities were obtained by multiple choice tests before learning (pretest) and after learning (posttest) in the experimental class and the control class. Furthermore, the pretest and posttest scores were analyzed to determine the effect and improvement of students' critical thinking.

Table 1 Results of critical thinking tests of the control and experimental classes

Source of Variation	Class	
	Control (XI MIPA 6)	Experiment (XI MIPA 7)
Pre-test Value		
The highest Value	50	53.3
Lowest Value	16.7	26.7
Average	34.0	43.3
Post-test Value		
The highest Value	80	96.7
Lowest Value	26.7	63.3
Average	59.1	80.9
Difference Score Post-test and pre-test		
The highest Value	14	17
Lowest Value	1	5
Average	6.08	12.2

Based on table 1, it shows that the critical thinking pretest of the experimental class and control class has an average below the KKM 75. However, after learning, the grades of the two classes increased. The posttest mean score of the experimental class (80.9) was higher than the control class (59.1). On the average result, the difference between the posttest and pre-test scores of the experimental class is higher (12.2) than the control class (6.08). This shows that the class treated using PBL with the Analyze Case Study obtained a higher average score than the class treated using the lecture and discussion method. The results of the critical thinking test of the experimental and control class students were tested for the difference between the two means using the parametric statistical test, namely the t test to determine whether there was a significant difference in the results of the critical thinking test between the experimental class and the control class. Before the t test is carried out, the prerequisite test has been carried out first, namely the normality test and the homogeneity test. The normality test was carried out with the help of the SPSS version 21 program. It is known that the Kolmogorov Smirnov significance criteria are $0.200 > 0.05$ and $0.074 > 0.05$, it can be concluded that the experimental and control classes are normally distributed. The homogeneity test is known that Leven's significance criteria $0.163 > 0.05$, it can be concluded that the two samples have the same variance. After fulfilling the prerequisite test, the two mean difference test was carried out with the t test.

Table 2 The t test results of critical thinking control class and experimental class

Data	Class	Average	Sig(2-tailed)	Information
	Control	6.08	0.000	There is a difference
	Eksperiment	12.2		

Based on table 2, it is known that the significance value is $0.000 < 0.05$, which means that H_0 is rejected. Therefore, it can be concluded that there is a significant difference between the control class using lecture and discussion learning and the experimental class using PBL learning with Analyze Case Study, so it can be stated that learning using PBL with Analyze Case Study has an effect on students' critical thinking test results. This is in accordance with the results of research by Ningsyih et al. (2016) stated that critical thinking can be improved by getting used to forming a thinking culture of students and student activities through practicum.

Practical activities provide opportunities for students to be directly involved in proving theory with practice in answering problems, so that students get meaningful learning experiences. The practicum was carried out in accordance with the design made by the teacher, namely the experiment of respiration in insects (crickets). This practicum aims to determine that O_2 is needed in the process of respiration, to determine the

volume of respiratory air in crickets, to determine the factors that affect the rate of respiration. This practicum is a learning step that can be done with practicum and discussion at the same time. The student worksheet provided by the teacher contains the steps of the scientific method, so that students can use them in experimenting as well as be used as a temporary report. The use of student worksheets is able to control the student activity process during learning, so that students can do scientific work systematically and in a disciplined manner.

After the observation is complete, each student analyzes and reports the results of the practicum in the form of a temporary report. Students are guided to find out the volume of breathing air in crickets. The format of the final practicum report is determined by the teacher and handwritten by the students by presenting the data and results of the practicum in the form of a table and compiling a logical explanation with scientific evidence to answer the problem formulations that are reviewed in the final report so that it can determine success in the practicum. Data analysis and preparation of practicum reports trigger students to think analytically and evaluatively and are skilled in connecting between variables. For example, the effect of giving KOH and what causes eosin to move on the scale pipe on the respirometer. Thus, it triggers students to identify problems to be more honed and accustomed to being used in everyday life. Identifying honed problems can develop students' critical thinking elements, namely Focus and Reasons. This is in accordance with the results of research by Dewi & Setyaningsih (2016) that critical thinking can be improved by practicum activities. Then performed the N-Gain test to determine the magnitude of the increase in critical thinking skills.

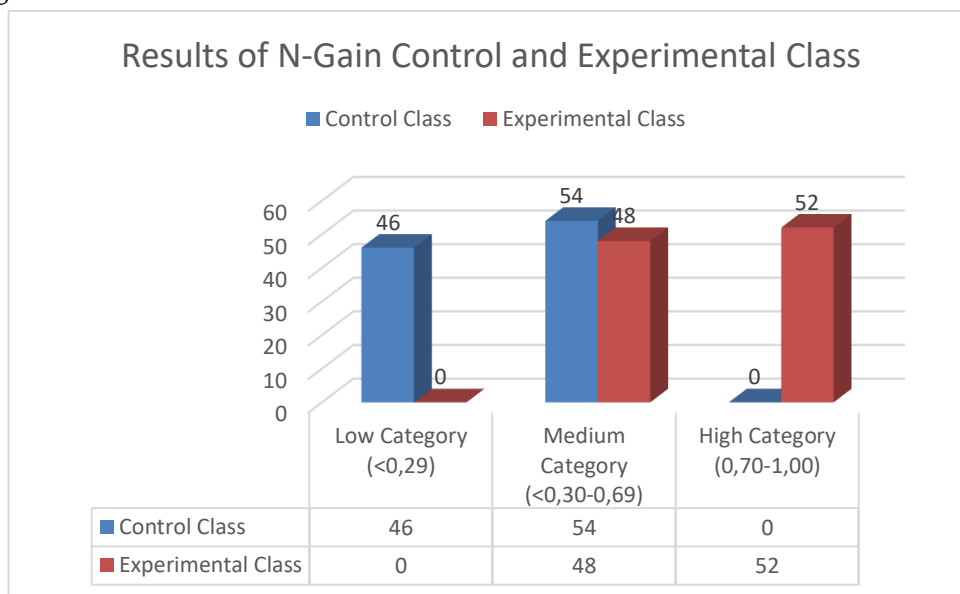


Figure 1 Results of the N gain for the control and experimental classes

Based on Figure 1, the N-Gain value of the experimental class in the high category was 52% and the medium category was 48%, while in the control class the moderate category was 54% and 46% low. After obtaining the N-gain, the t-test for the average N-gain score was carried out. The results obtained a significance value of $0.000 < 0.05$, which means that there is a difference between the N-gain of the experimental and control classes.

In the experimental class that uses the PBL learning model with the Analyze Case Study, the critical thinking test results are higher than the control class. Students solve problems from simple conceptual understanding to concepts that require higher order thinking skills. LDS and worksheets are designed to make it easier for students to understand the mechanism of chest and stomach breathing. For example, at LDS 1, first's meet presented problems in the form of abnormalities in the respiratory system that are often encountered on a daily basis. LDS 2 in second meet in the presence of a simulation of chest and abdominal breathing. Thus, students become more understanding and easier to remember, thus developing students' critical thinking skills by identifying problems and then being able to explain which can then be used in

making decisions, according to the research of Ramawati et al., (2016) argued that with critical thinking skills, someone can see things as a whole so that they can help solve the problem at hand based on strong reasons.

In discussion activities, students communicate and exchange ideas with their respective group members about the solution of PBL problems with Analyze Case Study logically and systematically according to the scientific method. Thus, students become trained to become accustomed to being critical and creative thinkers to train students to be sensitive to problems in everyday life. This is in accordance with that stated by Setiawati et al. (2017) that authentic learning considers all students to have the ability to understand and develop innovative solutions to complex problems through discussion activities that involve critical and creative thinking skills. PBL learning with Analyze Case Study makes students feel challenged to solve various problems and do activities. The learning process creates an atmosphere of competition between groups in the accuracy and speed of solving problems with effective discussion. This results in increased student activity. Each group competes in finding information and supporting data as complete as possible to solve problems in LDS.

Student Activities

Student activities in this study are student activities when the teacher explains, discussions and presentations. This student activity assessment aims to determine students' attitudes during learning. Student activities in the research that have been carried out include activities in paying attention to teacher explanations, answering questions from teachers or other students when presenting in front of the class, observing presentations from other groups, actively asking questions, being active during discussions. The results of the analysis of the activities of the control class and experimental class students are presented in table 3 as follows:

Table 3 Recapitulation of student activity scores in the experimental class and the control class

No	Aspects of Student Activities	Experiment class per meeting (%)					Control class per meeting (%)						
		I	II	III	IV	V	X	I	II	III	IV	V	X
1.	Heed the explanation	87,2	87,8	88,6	87,8	86,4	87,5	80,1	80	82,1	81,4	82,1	81,1
2.	Answer the question	80	80,7	84,3	85,7	84,2	82,9	75	75	77,1	74,3	75	63,3
3.	Observe the presentation	88,3	87,8	88,6	88,6	90	88,6	76,6	75,7	78,6	77,8	76,4	77,1
4.	Ask actively	85,3	85	87,2	85,7	84,2	85,5	76,3	74,3	76,4	77,8	77,1	76,4
5.	Active discussion	80,1	80,7	81,4	80,7	78,6	80,3	71,3	70,7	70,7	73,6	69,3	71,1
Average per meeting (%)		84,8	83	88,3	85,3	80,4	84,3	74,1	75,1	77	77	76	75,8
\bar{X} Last (%)		83,4					75,8						
Category		very good					good						

Table 3 shows that the student activities in the two samples during five meetings obtained an average result on good criteria. The experimental class has a higher average than the control class. The experimental class got an average value of 83.4%, which is in the very good category. In the control class, getting an average value of 75.8% is in the good category. Learning is said to be influential if the results of the experimental class students' activities are better than the control class, so it can be concluded that learning using PBL with

Analyze Case Study material on respiration system has a positive effect on student activity. Based on Figure 4, student activity with PBL learning with Analyze Case Study is better than the control class. Therefore, PBL learning with Analyze Case Study has a positive effect on students' critical thinking skills.

PBL Learning Implementation Level with Analyze Case Study

Implementation of PBL with Analyze Case Study needs to be measured for its level of implementation. Measurement of the level of learning implementation aims to determine how high the level of implementation of the learning plan that has been prepared, as well as to determine the effect of PBL with the Analyze Case Study on critical thinking skills. The level of implementation of PBL learning with Analyze Case Study is presented in Table 4 as follows:

Table 4 The results of categorizing the level of implementation of PBL with an Analyze Case Study of the respiratory system material in SMA Negeri 15 Semarang

Meeting	Value of PBL Learning	
	Implementation with ACS (%)	Category
1.	90,5	Very High
2.	80,9	Very High
3.	80,9	High
4.	85,7	Very High
5.	95,2	Very High
Average	86,6	Very High

Based on Table 4, it shows that the level of implementation of PBL learning with Analyze Case Study on the respiratory system material carried out in the experimental class during five meetings on average is very high, namely 86.6%. The results above indicate that the experimental class has implemented PBL learning with the Analyze Case Study well. Based on the analysis, the results of the critical thinking test in the experimental class were higher than the control class. This is supported by the learning process and the results of observations on the implementation of PBL with the Analyze Case Study on the respiratory system material with very good average results. The implementation of PBL learning with Analyze Case Study is it appropriate with the aspect of providing orientation about problems to students by asking questions, namely when giving perceptions and giving contextual questions that lead to finding problems related to the respiratory system material. Aspects Organizing or grouping students, with the indicator of distributing students into several groups, each group consists of 4-5 students, it can be seen whether the students are following the directions from the teacher. The next aspect of the teacher helps the investigation, namely the teacher guides students to discuss and solve problems, the teacher ensures that each group understands the problems being discussed. The next aspect of developing and presenting the work, namely the teacher facilitates students in presentation activities, students explain the results of group discussions in front of the class, groups that do not presentations respond to the results of presentations from groups that advance to the front. The next aspect is analyzing and evaluating the problem-solving process, namely the teacher together with the students analyzes the results of problem solving or the results of group presentations that advance to the front. The teacher encourages other groups to complete problem solving if there are things that are incomplete.

Apart from the teacher aspect, the implementation of PBL learning with Analyze Case Study is also seen from the activities carried out by students by directly observing the alert attitude to answer questions. Then students try to solve the problems in each group by not depending on just a few people but teamwork. Aspects when students discuss and present the results of the discussion can be seen starting when students collect information data and share assignments between groups. And the last aspect is the extent to which students understand the material that has been taught by asking directly at the time of reinforcement. In general, teachers and students have carried out a series of activities in learning according to the PBL syntax or stages with the modified Analyze Case Study from Arends.

Responses to PBL Learning with Analyze Case Study

Student responses are feedback given by students to the learning that has been implemented. Student response questionnaire data were obtained from the student response questionnaire sheets given at the end of the lesson. The results of the analysis of student responses are presented in Table 5.

Table 5 Results of student responses to PBL learning with Analyze Case Study

No	Statement item	Score (%)	Category
1.	I feel that learning PBL respiration system material with Analyze Case Study makes the learning atmosphere more enjoyable.	84	Very good
2.	I feel interested in learning the PBL respiration system with the Analyze Case Study.	86,9	Very good
3.	I feel interested in making observations when using the PBL model with the Analyze Case Study.	85,7	Very good
4.	I feel interested in explaining the results of observations of the respiratory practicum on crickets in front of the class during PBL learning with the Analyze Case Study.	80,6	Good
5.	I am interested in conducting discussion activities to work on LDS questions during PBL learning with Analyze Case Study.	83,4	Very good
6.	I am interested in presenting the results of the discussion in front of the class during PBL learning with Analyze Case Study.	88,6	Very good
7.	I was interested in conducting respiratory experiments on animals (crickets) during PBL learning with the Analyze Case Study.	78,3	Good
8.	I am interested in applying the concepts I have learned to answer questions during PBL learning with Analyze Case Study.	77,1	Good
9.	I feel motivated to follow PBL learning with Analyze Case Study, starting with analyzing problems related to the respiratory system.	83,4	Very good
10.	I feel motivated to analyze and provide an assessment of the respiratory system material to draw a conclusion.	85,7	Very good
11.	I feel challenged to compete with other groups during discussion activities.	85,7	Very good
12.	Learning PBL with Analyze Case Study makes me more active in learning.	81,7	Very good
13.	Learning PBL with Analyze Case Study made me more active in my opinion.	81,7	Very good
14.	Learning PBL with Analyze Case Study made me understand about the organs, functions and mechanisms of the respiratory system.	84	Very good
15.	I became more aware of the mechanism of respiration in animals through practicum activities.	82,3	Very good
16.	Learning PBL with Analyze Case Study increased my awareness to maintain the health of the respiratory organs.	87,4	Very good
	Average	83,5	Very good

Based on the results of Table 5, it shows that the average student reaches a percentage of 83.5% with very good criteria. The complete calculation data can be seen in the attachment. PBL learning with Analyze Case Study makes students interested in learning, motivated in learning, helps increase student activity in learning and helps students understand the material of the respiratory system.

Based on the statement items in the questionnaire, in general students can better understand the material because they have to actively seek out information for themselves and it is related to daily life and want to prove the information that students get with facts in real life. Communication patterns that exist during the learning process both between teachers and students and between students increasingly help students understand the material as a whole and answer the problems that have been presented to make students think logically and critically. This has an effect on developing critical thinking skills. This is evidenced by the results of the critical thinking test using the N Gain test, the average score of the

experimental class is higher than the control class. The activities and interactions that occur in the learning process in the experimental class are better than the control class.

Teachers' Responses to PBL Learning with Analyze Case Study

Teacher response data were obtained from the results of interviews containing questions about PBL learning with Analyze Case Study on the respiratory system. Teacher response data to complete learning is in Table 6.

Table 6 Results of teacher responses to PBL learning with Analyze Case Study

No	Question	Answer
1.	How do you respond to PBL learning activities with Analyze Case Study on the respiratory system material applied in class?	This learning is very good, because it can help students understand the material and trigger students' critical thinking skills with students faced with problems that are often encountered daily related to respiration.
2.	Does PBL learning with Analyze Case Study make it easier for students to understand the respiratory system material?	Yes, it is easier for students to understand the material well because students are required to discuss and find the concept of the respiratory system material.
3.	How do you respond if the PBL learning model with Analyze Case Study is applied to other materials?	Very good applied to other materials. Because biology learning is closely related to everyday life. This fits perfectly with the PBL concept.
4.	According to you, what are the advantages and disadvantages of learning PBL with Analyze Case Study on the respiratory system material?	Excess: Can stimulate students to be more creative, think critically by finding material concepts, practicing argumentation, working in groups and motivating students. Deficiency: Time is limited so that it is not flexible in applying the PBL learning series with Analyze Case Study.
5.	According to Mother, how is the effect of PBL learning with Analyze Case Study on student activities on the respiratory system material?	In my opinion, student activity increases. This can be seen from the student discussion process, student activity during presentations in front of the class and active in asking questions.
6.	According to whether there are difficulties in implementing the respiratory system learning using PBL with Analyze Case Study?	To be applied to other materials requires more time to prepare learning instruments compared to other models.
7.	Please share your criticisms and suggestions regarding PBL learning with the Analyze Case Study on the Respiratory System material?	Learning was good Criticism: If possible, the time needed is minimized again. Suggestion: you can add games at the end to make students more interested and enthusiastic.

Overall, the teacher gave a positive response to PBL learning with Analyze Case Study on the respiratory system. The teacher said that the PBL model with the Analyze Case Study can encourage students to think critically, students are faced with daily problems related to the respiratory system. In addition, PBL learning with Analyze Case Study can motivate students to actively discuss, train to argue in front of the class, and work together in groups. The difficulty that the teacher encountered during the learning process was limited time so that there was less flexibility in implementing the PBL learning series with Analyze Case Study. The teacher advised that the time needed to be minimized again and at the end of the lesson games could be added to increase the sense of competition between students and at the same time students were more interested and enthusiastic.

The success of implementing PBL learning with the Analyze Case Study can be seen from the responses of students and teachers after learning is carried out. The results of teacher responses to PBL learning with Analyze Case Study show that teachers give good responses with positive responses to learning. This is in line with the teacher's response that PBL learning with Analyze Case Study helps students

understand and foster students' critical thinking skills in the respiratory system material. Teachers who observe the course of the learning process are interested in applying PBL with Analyze Case Study to other materials, because biology learning is closely related to everyday life.

The teacher stated that by implementing the PBL learning model with the Analyze Case Study students became more motivated to show their ability in teaching and learning activities so as to increase student activity. This was proven when students made presentations in front of the class and were more active in asking questions. In PBL learning with Analyze Case Study it can spur students to be more creative, think critically by finding material concepts, practicing argumentation, and working in groups. However, this learning has obstacles in its application, namely limited time so that it is not free to apply the series of lessons.

CONCLUSION

Based on the results of research and discussion, it can be concluded that:

1. PBL learning with Analyze Case Study affects students' critical thinking skills in the respiratory system material.
2. The effect of PBL learning with Analyze Case Study can improve students' critical thinking skills by 52% with high criteria and 48% with the moderate category.

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