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Encouraging Students' Science Critical Thinking Skills Through a Problem-Based Learning Model

Nofita Wabadi Yaningsi[1], Muhammad Harja Efendi[1], Neneng Agustiningsih[1]✉

[1]Biology Science Education, Universitas Islam Negeri Mataram
Jl. Pendidikan No. 35, Mataram 83125, Indonesia
✉neneng.agustiningsih@uinmataram.ac.id

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Abstract: This study aims to improve students' critical thinking skills through the Problem Based Learning model in science subjects VII MTS Nurul Islam Sekarbela, Mataram. This type of research is quasi-experimental with a quantitative approach with a non-equivalent control group design. The population of class VII students are four classes, two female classes, namely VII A and B and two male classes, namely VII C and D, with a total of 120 students. The research sample is class A and B with a cluster random sampling technique by drawing lots to determine the experimental and control classes. Data collection techniques were observation and tests. The test instrument has been tested for the validity of 10 questions, the value of r_{count} (0.383-0.646) > r_{table} (0.381) and reliability of 0.570 with a reliable category. There are two data analysis techniques, namely descriptive, which consists of the analysis of the implementation of learning and critical thinking skills, and differential techniques consisting of normality testing, homogeneity testing and hypothesis testing. Hypothesis testing in this study uses the Ancova test (Analysis of Covariance) with a significance level of = 0.05 with test criteria. If the value of sig < 0.05, then H_0 is rejected, whereas if the sig value > 0.05, then H_0 is accepted. The data from the hypothesis test results show that H_0 is rejected and H_a is accepted. So this study concludes that there is an effect of problem-based learning on students' critical thinking skills in science.

Keywords: problem-based learning; critical thinking skills; biology.

A. Introduction

The learning process is useful for developing students' skills, activities, and creativity through various interactions and learning experiences (Janah & Widodo, 2013). Science learning is learning that should be faced directly with the object being studied, learning to connect the knowledge actively and creatively, namely by critical thinking. So, someone who thinks critically will always actively understand and analyze all the information obtained (Liberna, 2015).

Critical thinking is the key to developing creativity, where creativity arises because of seeing phenomena or problems. Critical thinking is a systematic and independent way of thinking that produces an interpretation, analysis, conclusion on

something, evaluation, and explaining something. Critical thinking skills are a tool in the long term. Critical thinking is reasoning, and reflective thinking emphasizes deciding what to believe or do (Fatmawati et al., 2014).

Critical thinking skills are very important for students because, with these skills, students can make the best choices for themselves. In addition, instilling the habit of critical thinking in students' needs to be done so that they can observe various problems that occur in everyday life (Jumaisyaroh et al., 2015). Critical thinking is a directed and clear process used in mental activities such as solving problems, making decisions, persuading, and analyzing assumptions (Nadiya et al., 2016). Critical thinking involves reasoning. Critical thinking is a process that involves mental operations such as deduction, induction, classification, evaluation, and reasoning. The importance of critical thinking skills is learning is carried out meaningfully for students (Syafitri et al., 2021).

Critical thinking has become necessary because of the various values of the thinking ability strategy to make a person independent. Critical thinking and thinking skills are two things that are interconnected. Critical thinking is a way of independent thinking that results in an interpretation, analysis, conclusion of something, evaluation, and explanation of something. Critical thinking skills are a tool in the long term (Dharma et al., 2019). Higher-order thinking skills are thinking skills that require not only memory but also other higher skills (Husein et al., 2017).

Problems often arise in implementing learning activities, especially science learning, which are teacher-centered and rote. Meanwhile, teacher-centered learning cannot improve students' critical thinking skills (Putri et al., 2020). Learning is an effort to create a condition for creating a learning activity that allows students to have an adequate learning experience (Anindyta & Suwarjo, 2014).

Interviews result with teachers in the field of science at MTs Nurul Islam Sekarbela Mataram. At the time of observation, the methods used by the teacher are the lecture method, discussion, assignment, and the assignment of package books or worksheets. So, what causes students' low critical thinking skills in science subjects is the lack of student interest in receiving lessons using inappropriate methods. When the teacher asks questions or problems related to everyday life during the learning process, students cannot answer or solve problems systematically and draw conclusions (N. W, personal communication, March 21, 2022).

One learning model that can improve the skill is problem-based learning. Problem-based learning (PBL) is a learning model that uses the real problem faced in the environment to be the base for gaining knowledge and concept by critical thinking and solving the problem (Fakhriyah, 2014). This model exposes students to problems or learning based on problems. Through this model, it is expected to be able to explore and develop information with problems that exist in students' daily lives (Yahdi et al., 2020).

Problem-based learning model has advantages in the learning process. These advantages are described by the Ministry of Education and Culture, namely a meaningful learning process for students, where students learn to solve problems by

applying their knowledge. Students integrate knowledge and skills simultaneously and apply them in relevant contexts, improve critical thinking skills, foster student initiative in work, internal motivation in learning, and develop interpersonal relationships in group work (Haryanti, 2017).

Wahyuni's research explained that the problem-based learning model improved students' critical thinking skills (Wahyuni et al., 2017). It was also found that the student's skills in critical thinking in the experimental class after using the PBL model had improved quite well (Hartati, 2015). The results showed that the critical thinking skills of students who were given problem-based learning were higher than those who were given direct learning (Jumaisyaroh et al., 2015). So, this study aims to determine the effect of problem-based learning models on critical thinking skills in science subjects for seventh-grade students of MTs Nurul Islam Sekarbela Mataram.

B. Method

The type of research used in this study is a quasi-experimental method. Quasi-experimental research is a type of quantitative research to measure causal relationships. The research design used is the equivalent control group design. This research was conducted at MTs Nurul Islam Sekarbela, Mataram. The instruments used in this study were tests and observations. The type of test used is in the form of 10 descriptive questions with techniques, namely pretest and posttest, where this instrument has met the criteria of validity and reliability. The results of the validity test of students' critical thinking skills showed that the value of r arithmetic (0,383, 0,391, 0,416, 0,417, 0,430, 0,445, 0,494, 0,548, 0,585, 0,646) > r_{table} (0,381) for items numbered 1 to 10. That is, the test of critical thinking ability instruments was all valid with a significant level of 5%. The reliability test results show that the reliability value is 0.570 on the reliable criteria.

The observation sheet aims to measure the implementation of learning. Indicators for the experimental class of learning steps using a problem-based learning model and the control class using conventional learning with lecture and question and answer methods. The population in this study were all class VII students, totaling 120 students at MTs Nurul Islam Sekarbela, while the samples in the study were two classes totaling 60 students consisting of 30 students in class A as the control class and 30 students in class B as the experimental class. Sample selection by lottery with cluster random sampling technique. The data in this study were analyzed through descriptive data on the implementation of learning and critical thinking skills. The differential analysis consists of normality testing, homogeneity testing, and hypothesis testing using the Ancova test (analysis of covariance) at the significance level = 0.05 with what test criteria if the sig value < 0.05, then H_0 is rejected, whereas if the sig value > 0,05 then H_0 is accepted.

C. Result and Discussion

1. The Implementation of Problem based learning

The implementation of learning was measured using an observation sheet using the Gutman scale in two meetings. The experimental class indicators of learning steps use a problem-based learning model, and the control class uses conventional learning with lecture and question-and-answer methods—obtained learning implementation data in Table 1.

Table 1. The Learning Implementation

Meeting	Experiment Class	Control Class
Meeting 1	75	75
Meeting 2	85	75
Percentage	80	75

The material in this study is the interaction between living things and their environment contained in the basic competence (KD), namely analyzing the interaction between living things and their environment and population dynamics due to these interactions. The concept of the environment and its components. At the first meeting, the sub-materials studied were analyzing the interactions between living things and their environment, observing the environment, and identifying biotic and abiotic components. At the second meeting, the sub-materials studied were the understanding and patterns of interaction, the concept of interdependence of living things, the difference between food chains and food webs, detritus food chains and grazing food chains.

The steps of the problem-based learning model are as follows: (1) student orientation to the problem, where the teacher explains the learning objectives, explains the steps of the activities to be carried out, motivates students to be involved in solving the chosen problem; (2) organizing students for learning, where the teacher helps students define and organize learning tasks related to the problem; (3) guiding individual and group investigations, where the teacher encourages students to collect appropriate information, carry out experiments, to get explanations and problem-solving; (4) developing and presenting work, where the teacher helps students plan and prepare appropriate works such as reports, videos, and models and helps them share assignments with their friends; and (5) analyzing and evaluating problem-solving processes in which teachers help students reflect or evaluate their investigations and the processes they use (Syafitri et al., 2021).

Learning with a problem-based learning model begins with the student orientation stage on the problem. In this study, students were given problems identifying biotic and abiotic components in the environment around the school so that students could clearly understand the problem directly. This stage can train students to develop students critical thinking skills. Students can group the problems received so that they have a clear meaning. Fitriyyah and Wulandari (2019), stated that learning by giving problems to students, and these problems were solved by students so that active learning could be created.

The next stage is to organize students to learn. In this study, the teacher directs students to form groups and collect information related to the problems given through direct observation in the field by collecting various living and non-living objects, as well as collecting information related to the characteristics of biotic and abiotic components in the worksheet and assisted by textbooks. This stage involves organizing students into study groups to conduct investigations and report student assignments. Organizing students in groups can develop collaboration or cooperation skills among students and facilitate them in solving problems.

The third stage assists independent or group investigations. In this study, students were guided to carry out simple investigations related to identifying biotic and abiotic components and answered several questions related to the problems in the worksheets to direct students in analyzing appropriate problem-solving. The free exchange of ideas between group members also supports investigations to find solutions to problems. This stage develops students' critical thinking, including aspects of analysis. The ability to analyze and develop arguments is the basis for critical thinking skills (Nuraida, 2020). It can happen because students are trained to solve problems and present the results of discussions in front of the class; students are required to actively participate in asking and responding to questions to develop their critical thinking skills (Kurniahtunnisa et al., 2016).

The fourth stage is developing and presenting the work. Students present data in tabular form to identify biotic and abiotic components and explain specific characteristics as differentiators resulting from their work after investigating the problem. The results of the work can not only be in the form of written works such as reports but also in the form of presented tables and explanations. The results are presented to each group, sharing the task with their friends. It is because thinking is an ability that must be trained and cannot be obtained instantly. It aligns with Redhana's statement that critical thinking skills require continuous learning and practice. It is supported by Soyomukti, who said that critical thinking is not an ability that can develop on its own but a skill that must be learned and trained, both in formal education and everyday life (Kurniahtunnisa et al., 2016).

The last stage is analyzing and evaluating the problem-solving process. Activities at this stage help students analyze and evaluate their thinking processes, from investigation to finding solutions. The process of evaluating everything that children do is a critical thinking process. Students can test ideas, recognize reasons and statements, make conclusions in problem solving, and assess statements or opinions from others. Critical thinking is a directed and clear process used in mental activities such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research. The mental process analyses or evaluates information (Nadiya et al., 2016).

The problem-based learning model has the advantage that students are directed to have the ability to solve skills in real conditions; through the learning process, students build their potential knowledge independently; learning focuses on one problem so that students do not need to study material outside the problem. Through

group work, there will be a scientific activity for students. Students tend to use the library, the internet, interviews, and observations as sources of knowledge. Students can assess the extent of their learning abilities, students can carry out scientific communication in discussion activities or the presentation of their work, and through group work, they can overcome individual student learning difficulties. The advantage of this learning model is that students can connect concepts in biology with real problems in everyday life and provide opportunities to show their best abilities. Students are trained to take on responsibility and sharpen their thinking skills at a higher level through problem identification, problem analysis, and creating solutions. (Rachman, 2018).

2. Critical Thinking Skills

Students' critical thinking skills were measured using a pretest and posttest in the experimental and control classes with as many as 10 questions and descriptions; the results are in Table 2.

Table 2. Students' critical thinking

No	Class	Test (average)		Improvement
		Pretest	***Posttest***	
1	Experimental	56,36	83,26	26,9
2	Control	54,86	76,03	21,03

The process of learning science, in addition to understanding concepts related to natural phenomena and how the process occurs through sensing as much as possible, observing events directly through demonstrations, experiments, and recording information that appears. Active student involvement in exploring subject matter, and constructing the ideas obtained, can make it easier for students to master the material and improve thinking skills (Fahmi et al., 2021). Critical thinking in science learning is the need to prepare students to become strong problem solvers and make mature decisions (Fahmi & Irhasyuryana, 2019), so according to Reddington (2012), the most effective way to develop it is through application in learning activities by providing questions, lessons, and activities that focus on higher-order thinking skills. Problem-based learning models can improve students' critical thinking skills (Susilo, 2012).

The problem-based learning model is a learning model that requires students to be more active in the learning process. Problem-based learning models provide opportunities for students to work like scientists, including formulating hypotheses, testing hypotheses through experiments and informing the results. Problem-based learning is one solution to overcome boring and boring learning, where this learning is a pattern of interaction between students and teachers in the classroom which involves strategies, approaches, methods, and learning techniques applied in the implementation of teaching and learning activities in the classroom (Suma et al., 2013). The opinion above is by the results of research conducted by researchers, where through problem-based learning steps students are more active during the learning process and can improve students critical thinking skills.

Students' critical thinking skills are measured in five indicators represented by the two questions. The results obtained in the experimental and control classes are as follows in Table 3.

Table 3. Indicators of critical thinking skills

No	Indicators of Critical Thinking Skills	Average		Category
		Experimental Class	Control Class	
1	Application	70	60	Critical/Quite Critical
2	Evaluation	52	52	Quite Critical
3	Using data to develop critical insights	58	54	Quite Critical
4	Analysis	46	42	Quite Critical
5	Synthesis	55	56	Quite Critical

From the table above, the difference in the average value per indicator of the experimental and control classes can be seen. The indicators of applying, using data to develop critical insights, and analyzing the experimental class have higher scores.

Critical thinking skills in science learning can develop if basic skills. They are carefully explaining nature, formulating alternative hypotheses and theories, planning, and conducting controlled experiments to test hypotheses, collecting, and analyzing data and drawing conclusions (Burmester in Lawson, 1995) can be developed well, one of which is through problem-based learning, students are involved in solving problems.

Problem-solving activities can develop critical thinking skills and deepen students' understanding of the concepts being studied. When students are involved in solving problems, they feel they have a role in finding solutions to existing problems. Through this understanding, students' awareness grows to take real action in solving problems given by the teacher. Student awareness appears in line with the increase in students' understanding of why action must be taken and how the impact of the action will be (Anindyta & Suwarjo, 2014).

The power of science learning to build thinking skills lies in the ability to formulate hypotheses that spur the development of various thinking skills through experimental or practical activities, beginning with the ability to observe from direct and indirect experience. Thus, it is important for students to become independent thinkers, in line with the various types of work in the future (Norrizqa, 2021).

The most significant experimental indicators, based on the five critical thinking indicators, are indicators of implementation, and the other indicators are quite critical. Overall, it can be seen in Figure 1.

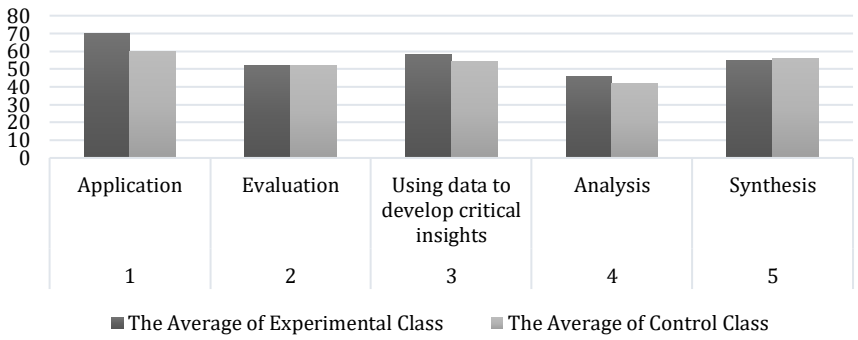

Figure 1. Graphic of critical thinking indicator

3. Problem-Based Learning Model for Critical Thinking Skills

Based on the results of this study, the problem-based learning model affects students' critical thinking skills in science at MTs Nurul Islam Sekarbela Mataram. The difference between students' critical thinking skills using problem-based learning models (there is an increase in grades) and students using conventional methods can be seen.

To see the effect of students' critical thinking, a differential analysis was carried out, which previously carried out a prerequisite test, namely the normality test using the Kolmogorov Smirnov formula. The normality test aims to determine whether the data is normally distributed.

Based on the normality test's value, the experimental class's pretest value was 0.146 > 0.05, and the posttest value of the experimental class was 0.200 > 0.05. While the pretest value of the control class was 0.158 > 0.05 and the posttest value was 0.167 > 0.05. It can be concluded that all data are normally distributed.

Obtained data with normal distribution, then continued with homogeneity test analysis. This homogeneity test was conducted to determine whether the variance of the two samples was homogeneous or not. From the homogeneity analysis, it is known that the significant result is 0.102. It indicates that the sig value is 0.102 > 0.05, so it is concluded that the two data groups have the same variance (homogeneous).

After knowing that the data is normally distributed and homogeneous, the next test is to test the hypothesis using the Ancova test (analysis of covariance) with a significant level of = 0.05 with the test criteria if the value of sig < 0.05 then H0 is rejected, whereas if the value of sig> 0.05, then H_0 is accepted.

Based on the hypothesis test above, it shows that H0 is rejected, and Ha is accepted. It shows the effect of the problem-based learning model on the science critical thinking skills of seventh-grade students at MTs Nurul Islam Sekarbela Mataram West Nusa Tenggara.

The experimental class uses a problem-based learning model; it is a learning model that requires students to be more active in the learning process. Problem-based learning model can improve students' critical thinking skills because this learning model provides opportunities for students to construct their knowledge. Problem-based learning models can develop and improve critical thinking skills and make students active because the material discussed is about everyday life (Prasetyo & Kristin, 2020).

Critical thinking skills are the ability to solve problems by finding, analyzing, and evaluating good reasons for solving subject problems, and they will always be sensitive to the information or situations they face. The ability to think is the basis of a learning process. Critical thinking allows students to analyze their minds in making choices and drawing conclusions intelligently. Critical thinking skills are thinking that is always curious about information to achieve a deep understanding (Yustyan et al., 2015).

Problem-based learning model has a very big role in developing students' critical thinking skills. Students' critical thinking skills can be developed in the learning

process. Through the steps of the problem-based learning model, a person is said to have critical thinking skills if students can provide reflective, productive, and evaluative answers to a problem regarding an event. Thus, the use of problem-based learning models is very important to be applied in the learning process because it is by education in the context of the 21st century. It is because education in today's era encourages students to be more responsive to changing times.

D. Conclusion

In this study, it was concluded that using problem-based learning models effectively improved students' critical thinking skills because this learning model was problem-based. In the learning process with this model, the teacher explains and motivates students to solve problems, organizes students in learning tasks related to these problems, and encourages students to collect information. Based on the results of hypothesis testing using Ancova, it was obtained that a sig of 0.000 was smaller than a sig of 0.005, indicating that H0 was rejected, and Ha was accepted. It shows the influence of the problem-based learning model on the science critical thinking skills of seventh-grade students at MTs Nurul Islam Sekarbela Mataram NTB. The problem-based learning model will be more effective if utilized by teachers who are well-versed in the learning syntax. The problem-based learning model will be more effective in the research environment if it is utilized to measure a variable in conjunction with the usage of learning materials and media.

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