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# Learning Biology Through the Ethnoscience-PBL Model: Efforts to Improve Students' Scientific Thinking Skills

Lia Sania Nur Haulia*, Sri Hartati, Asrianty Mas'ud

[a] Biology Education Study Program, Department of Mathematics and Sciences, Faculty of Tarbiyah and Teacher Training, UIN Sunan Gunung Djati Bandung, Indonesia

*Corresponding author: Cimincrang, Panyileukan, Kota Bandung, Jawa Barat, 40292, Indonesia. E-mail address: saniaauliya19@gmail.com

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**a b s t r a c t**

This study was intended to analyze the effect of the ethnoscience-based Problem Based Learning (PBL) model on scientific thinking skills in reproductive system material. This research is a quasi-experimental design in the form of a pretest-posttest non-equivalent control group design. This research was conducted at class XI MIPA students for the 2022/2023 academic year in Sumedang. The research instruments used were pretest-posttest sheets and questionnaires. The data collection technique used in this study included a test of 15 essay questions and a questionnaire. The data analysis technique used is the normality test, independent sample t-test, and N-Gain test. The results showed that the students' scientific skills increased significantly after applying the ethnoscience-based learning model on the material of reproductive system. The independent sample t-test obtained p-value = 0.000 <0.05, which was significantly different between the posttest and pretest scores. N-Gain also obtained an average of 0.75 which indicates an increase in students' scientific skills in high category. The results of students' responses to learning with the ethnoscience-based PBL model on students' scientific thinking skills were included in very good category with an overall percentage of 82.5%. This study concluded that students' scientific thinking experienced an increase after learning through the ethnoscience-based PBL model on the reproductive system material.



## 1. Introduction

The rapid development paradigm of the 21st century requires individuals to be able to adapt to every aspect of life (Partnership for 21st Century Skills, 2009). One aspect developing rapidly in the 21st century is the field of science and technology (Bybee, 2013; National Research Council (NRC), 2012). The development of science and technology in the 21st century has an impact on the world of education (Partnership for 21st Century Skills, 2009). This impact occurs on the competency of graduates to be ready to face global challenges (NRC, 2011; Kanematsu & Barry, 2016; Rahmawati et al, 2019; Agustina et al, 2020a). Schools as educational institutions face the challenge of being able to provide opportunities for students in terms of mastering science and technology in their curriculum (Bybee, 2013). Indonesia's education curriculum has been designed based on 21st century conditions to require students to master science and technology (IPTEK) (National

Education System Law, 2003; Kemdikbud, 2013). Hence, education at this time must emphasize the mastery of science and technology by students as the generation that will live in the future.

The 21st century challenges students to excel and be competitive in utilizing information. Therefore, human resources are expected to master a variety of HOTS expertise and skills. This requires students to be able to explain scientific processes such as making new discoveries by utilizing existing problems in the surrounding environment (Imaningtyas et al., 2018). One of the high-order thinking skills that students must have is scientific thinking skills. Scientific thinking skills are the most important aspect of higher-order thinking, because a more thorough and broad thinking process starts with thoughts associated with scientific thinking (Khun, 2010; Malik & Ubaidillah, 2020).

Scientific thinking is a form of seeking knowledge that involves thinking processes to increase knowledge or intellectuality. Thus, the ability to think scientifically is not what is in one's mind but the thinking process must be accustomed to encourage the increased knowledge (Khun, 2010). Scientific thinking skills are able to develop students when arguing according to facts and experiences when investigating science (Rudolph & Horibe, 2016). In Indonesia, several studies have been conducted to find out the level of students' high-order thinking skills, especially scientific thinking skills, which are still relatively low. Whereas by having scientific thinking skills, a person will have the ability to receive, process, and evaluate the information he gets according to the context of his knowledge (Bao et al., 2009). However, the fact is that the level of scientific thinking ability in one of the schools in Indonesia that was sampled shows a fairly low number. There are several aspects found, for example students pay less attention to the teacher during the teaching and learning process. In addition, learning physics only presents formulas without knowing the purpose and many students lack self-confidence. The effect is that they usually give the same answers as their classmates (Retnowati, 2020).

Based on the interview results with a Biology teacher at a high school in Sumedang Regency, the current study of Biology has not led to the provision of scientific thinking. Biology learning that has been implemented has implemented various practicum activities or experiments but problem-based practicum activities based on phenomena around students' lives that can train scientific thinking have not been carried out. Student assessments carried out also did not lead to indicators of scientific thinking. Reproductive system material is only understood by students as an abstract concept, not yet directed at real-life actualization even though this material is very closely related to students' lives. Based on these problems, learning that is oriented towards training in scientific thinking is needed which directs students to be able to solve problems around them. But results Indonesian students' scientific thinking is still low. Based on Program research results for International Student Assessment (PISA) latest 2018, country Indonesia obtained an average score of 371 in the science category with ranked 70th. This result is still less than the average score set by the OECD, namely 487 (NCES, 2018). The results of the PISA assessment in previous years also showed that Indonesia had not been maximal in equip higher order thinking skills (OECD, 2006; Toharudin et al, 2011; Yuliati, 2017). Scientific thinking skills are very low because the learning used by the teacher is not yet let students actively construct his own knowledge. Learning that carried out in schools is still centered on teachers, besides that learning is also not implementing based learning inquiry, so that learning is less empowering students' deep scientific thinking skills learning (Khabibah et al., 2017; Yohana et al., 2018; Roviati et al., 2019; Nazila et al., 2019; Dahm et al., 2019).

Indonesia is a country where people have a lot of cultural diversity, local technology, and noble values that need to be instilled and socialized to students through the learning process (Khoiriyah & Husamah, 2018). The learning process in schools is considered not focused on real life problems that require students' critical and creative thinking skills. In addition, the learning that is carried out is not focused on local cultural issues that develop in the area. Therefore, this study aims to analyze students' scientific thinking skills after applying a problem-based learning model that includes ethnoscience (Ulger, 2018; Thomas, 2009; Purba et al., 2017).

Seeing the current condition of students who need to improve scientific thinking, there needs to be appropriate efforts to overcome students' low scientific thinking. Based on this statement, efforts to develop students' scientific literacy can be fulfilled through efforts to implement ethnoscience learning in the teaching and learning process. Contextual learning can train students' scientific thinking skills to support students in connecting science concepts with life's problems and motivate them to develop the knowledge gained. The current science education paradigm is ethnoscience-based science learning, one of the efforts to improve scientific thinking skills. Learning with an ethnoscience approach prioritizes realizing systematic knowledge rather than just in-depth knowledge. Students confront the topics studied with the context of their activities and their relationship to science and technology. Therefore learning is not only informative but also practical and useful for life. The reproductive system as one of the materials in biology still has very strong cultural aspects and is still a public belief, such as ritual beliefs in the process of pregnancy, as well as values in the form of taboos and recommendations related to menstruation, pregnancy and maintaining reproductive health. These values are cultural values, or commonly known as local wisdom, which develop and are passed down from generation to generation. The concept of reproductive system material incorporated in local culture can easily be found in student environments. The environment around students who are still thick with culture can be used as an appropriate learning resource in exploring the concept of reproductive system material, thus making learning more meaningful by utilizing learning resources and direct student involvement in acquiring concepts (Temuningsih, 2017).

The ethnoscience approach can be integrated into various learning models, one of which is Problem Based Learning (PBL). This learning model is student-centered, collaborative, and emphasizes the application of scientific knowledge, creativity, and problem solving based on unique knowledge. The original knowledge to be integrated can be in the form of language, customs, culture, morals, and techniques created by certain people or people who have scientific knowledge (Rudibyani, 2019; Savery, 2006; Sumarni et al., 2022; Thaniah & Diliarosta, 2020; Khoiri et al., 2018; Sudarmin et al., 2020; Ariyatun et al., 2020). The PBL learning model is properly integrated with the ethnoscience approach because it can create meaningful learning. Learning by doing which directs students to be able to make attachments that produce meaning (Wahyu, 2017), so that students are able to connect the content of academic subjects with the context of life through an ethnoscience approach based on constructivism. Students' scientific thinking skills were analyzed after applying the ethnoscience-based PBL model to the material on the reproductive system.

## 2. Method

This study is a quasi-experimental design with a pretest-posttest non-equivalent control group design. The first stage in this research is to determine the research sample and group it into two research classes, namely the experimental class and the control class. The next stage is to give a pretest to measure scientific thinking skills before being given treatment using an ethnoscience-based PBL model. The next stage in the experimental class is given treatment. Then, in the last stage, all samples were given a posttest to measure scientific thinking skills after being given treatment.

The research was carried out in the odd semester of the 2022/2023 school year. The population used was students of class XI MIPA totaling 86 students. Samples were taken using a purposive sampling technique, XI MIPA 1 as the experimental class (using the PBL model based on an ethnoscience approach), while XI MIPA 2 as the control class (using a discovery learning model based on a scientific approach). The independent variable in this study is the influence of the ethnoscience-based PBL model, and the dependent variable is students' scientific thinking skills. The research instruments used were pretest-posttest sheets and response questionnaires. The pretest-posttest sheet consists of 15 essay questions which refer to indicators of scientific thinking which refers to (Khun, 2010) with four aspects, namely Inquiry, Analysis, Inference, and Argumentation. The response questionnaire is a Likert scale type consisting of six statements using a score of 4 if you strongly agree, a score of 3 if you agree, a score of 2 if you disagree, and a score of 1 if you strongly disagree to find out the response students about the results of applying the PBL model based on an ethnoscience approach in learning. Tests and questionnaires are data collection techniques used in this study.

The data analysis technique used to analyze the results of the pretest and posttest will then be analyzed using the normality test, homogeneity and hypothesis testing, namely the t-test with independent samples test and the N-Gain test. This test was carried out using the SPSS application version 26. This normality test was carried out to find out whether the data is normal or not. If the sig value > 0.05 then $H_0$ is accepted which means the data is normally distributed, if the sig value < 0.05, then H0 is rejected which means the data is not normally distributed. Then the N-Gain test was carried out to see the increase in pretest and posttest results. The following formula can be used to calculate the N-Gain. After obtaining the N-Gain score, the updating category can be identified through a defining process according to Hake (1999), namely $g \geq 0.7$ is high criteria, $0.7 > g \geq 0.3$ is medium criteria, and $g < 0.3$ is low criteria. The percentage of respondents who have been calculated through the equation towards learning with the ethnoscience-based PBL model on the subject of the reproductive system. Percentage criteria for student response enforceability to Ridwan (2012), 0% - 20% is very less criteria, 21% - 40 % is less criteria, 41% - 60% is enough criteria, 61% - 80% is good criteria, and 81% - 100% is very good criteria.

## 3. Result and Discussion

The research was conducted in three face-to-face meetings in the classroom using reproductive system material. The learning model used is the Problem based learning model where the learning steps consist of five stages. The first phase is the orientation of students to the problem. The second phase is organizing students to learn, and the third phase is the teacher guiding individual and group investigations. The fourth phase is students develop and present the results of their work. The fifth phase is when the teacher and students analyze and evaluate the problem-solving process.

Data on students' scientific thinking abilities were obtained from the average pretest, posttest, and six indicators of students' scientific thinking abilities during the study of the reproductive system material. The data used to test normality, homogeneity and hypothesis testing are posttest results using 15 items of description/essay questions. From the data obtained, the pretest, posttest, Gain, and N-Gain of the experimental class are shown in Table 1.

**Table 1**. The average value of the scientific thinking skills of students with the ethnoscience-based PBL model

| Data | Pretest | Posttest | Gain | N-Gain |
|---|---|---|---|---|
| N | 24 | 24 | - | - |
| Minimum Value | 32 | 78 | - | - |
| Maximum Value | 50 | 92 | - | - |
| Average | 42,71 | 86,11 | 43,4 | 0,75 |

The N-Gain value of 0,75 has high criteria which means there is an increase in scientific thinking skills using the ethnoscience-based PBL model. There was an increase in students' posttest scores due to the influence of the ethnoscience-based PBL model. Ethnoscience-based PBL models that are oriented towards problem solving can provide experience to meet the needs of students' thinking aspects in achieving scientific thinking skills. This is in line with the theory that the ethnoscience-based PBL model can help students think and practice thinking skills by integrating the existing culture in the surrounding environment, which means that the ethnoscience-based PBL model is successful in providing learning experiences (Aulia & Hamid, 2021), besides that according to research by (Nisa et al., 2015) in the research journal (Ramandanti & Supardi, 2020) integrated learning of ethnoscience in problem-based learning provides opportunities for students to be directly and actively involved in scientific activities and provides direct experience to students regarding science learning in the context of local wisdom so that the concept that students receive is easy to remember. The average values of pretest, posttest, Gain, N-Gain for the control class without using the ethnoscience-based PBL model can be seen in Table 2.

**Table 2.** The average value of the scientific thinking skills of students without the ethnoscience-based PBL model

| Data | Pretest | Posttest | Gain | N-Gain |
|---|---|---|---|---|
| N | 24 | 24 | - | - |
| Minimum Value | 30 | 63 | - | - |
| Maximum Value | 52 | 85 | - | - |
| Average | 40,42 | 72,22 | 31,39 | 0,53 |

Based on Table 2 above, the N-Gain value of 0,53 has moderate criteria, which means that there is an increase in scientific thinking skills without using the ethnoscience-based PBL model, but the increase is not as big as the class using the ethnoscience-based PBL model. For more details regarding the difference in the acquisition of the average grades of classes using and not using the ethnoscience-based PBL model, see Figure 1.

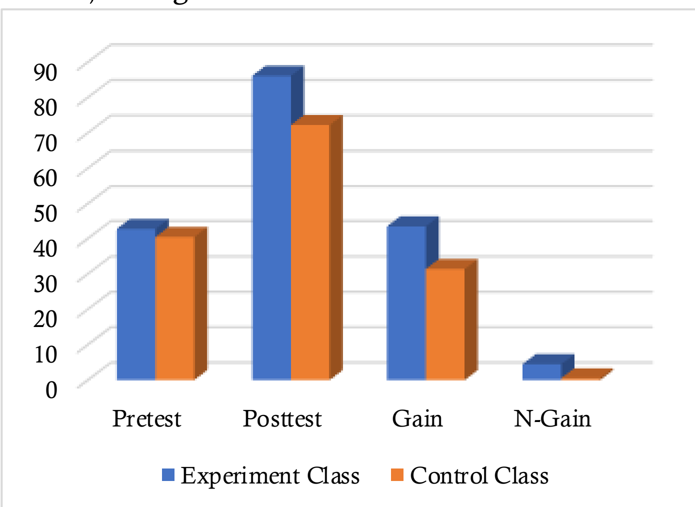


**Figure 1.** Diagram of obtaining the average value of pretest, posttest, Gain, N-Gain in Classes with and without using ethnoscience-based PBL models

Figure 1 shows the average value of students' scientific thinking skills in the class with and without using an ethnoscience-based PBL model. Based on data both classes experienced an increase in the average value of scientific thinking skills which indicated in the posttest scores. In the experimental class obtained a higher value than control class. This happens because in the learning process in the experimental class students required to be active and discuss with the group to solve problems. Besides that, with an ethnoscience approach to make learning more interesting which can trigger student motivation to learn. In the learning control class using a discovery learning model with a scientific approach, but students have not carried out their learning optimally. Students are less active in participating in learning. In addition, less given learning experience to develop scientific thinking skills, so that students' scientific thinking skills are lacking.

After knowing the average value of the pretest and posttest in the experimental class which using an ethnoscience-based PBL model and a control class that does not using the ethnoscience-based PBL model, then the calculation of the test is carried out normality, homogeneity test and hypothesis testing. From the two samples obtained data normally distributed and the variance is homogeneous, so that the hypothesis is tested using the test t. The results of the t-test calculations can be seen in Table 3.

**Table 3**. Results of the posttest hypothesis test

| **Aspect tested** | **Independent Samples Test** | | |
|---|---|---|---|
| | $\alpha$ = 0,05 | | |
| Skills scientific thinking | Experiment (n = 24)<br>Control (n = 24) | $t_{count}$ = 9,013 | $t_{table}$ =1,98 |
| Conclusion | $H_0$ is rejected, $H_a$ is accepted | | |

Based on Table 3 above, the results of the t-test analysis (hypothesis testing) on the posttest value of the experimental class and control class resulted in $t_{count} = 9.013 > t_{table} = 1.98$, then as the basis for decision making in the independent samples test T-test it can be concluded that $H_0$ is rejected and $H_a$ is accepted, which indicates that there is an effect on students' scientific thinking skills using the ethnoscience-based PBL model.

The existence of a significant influence on the scientific thinking skills of the experimental class and control class students is indicated by an increase in the students' posttest scores. This increase occurs in every indicator that represents aspects of scientific thinking. There are four aspects of scientific thinking skills with six indicators that contain them, namely; the aspect of inquiry which has three indicators, namely formulating goals, identifying phenomena, and formulating problems; aspects of analysis with indicators of designing the experimental design; aspects of inference with indicators to make conclusions; argumentation aspects with indicators to solve problems using experimental theory (Khun, 2010).

The difference in students' scientific thinking skills in the experimental class and control class occurs because of a more meaningful learning experience when learning using an ethnoscience-based PBL model. The ethnoscience-based PBL model that is oriented to problem solving can provide experience to meet the needs of students' thinking aspects in achieving scientific thinking skills. This is in line with the theory that the ethnoscience-based PBL model can help students think and practice thinking skills by integrating the existing culture in the surrounding environment, which means that the ethnoscience-based PBL model is successful in providing learning experiences (Nabilah et al., 2022), besides that according in the research Patricia et al. (2022) integrated learning of ethnoscience in problem-based learning provides opportunities for students to be directly and actively involved in scientific activities and provide direct experience to students regarding science learning in the context of local wisdom so that the concept of received by students is easy to remember.

Some experts argue that scientific thinking skills can be trained through learning. According to Khun (2010) scientific thinking skills can be trained with constructivism-based learning that allows students to actively build their own knowledge. So we need a learning model that is student center. So that the ethnoscience-based PBL learning model affects scientific thinking skills because students become more active with student-centered learning where they are given problems and are required to find and read more material to solve these problems. Learning by using scientific thinking skills makes students very enthusiastic in learning because students can find a new concept without the help of the teacher. Students' scientific thinking skills begin to be grown by the teacher through providing contextual problems when starting learning activities. The use of contextual problems in the PBL model is a stimulant given by the teacher in growing students' attitudes to be interested in science. According to Herzon et al. (2018) through the problems given to students, it is hoped that it can foster curiosity so that students are motivated to seek information in solving the problems they face.

Task performance can also be an indication of the influence of students' scientific thinking skills because students are trained on the scientific method as outlined in the performance task. Giving performance tasks at the beginning of learning will create collaborative, cooperative learning and work together in groups which are characteristics of the PBL model. In addition, the PBL model has the advantage that it can establish social solidarity by getting used to discussing with group friends and being able to familiarize teachers and students. Performance tasks allow students to develop other thinking skills as is the scheme of the ethnoscience approach (Bybee, 2013; Fitriyanti et al., 2020; Agustina et al., 2020a). This can be a factor in the increase in students' scientific thinking in the experimental class. Learning in regular classes is also of course certainly emphasizes the aspect of thinking in science but is not synergized with ethnoscience approach. Based on this, learning in regular classes can also allow the development of student knowledge at the time answer questions that contain indicators of ethnoscience in questions of scientific thinking so that it can lead to an increase in contribution as well.

This series of learning activities can encourage students to think scientifically through mental activities in the form of the ability to deduce theories by involving students' cognitive abilities as rationality support in an effort to solve problems on the topics studied. This causes students to be able to integrate indigenous knowledge of society with biological sciences. Problem-solving activities can trigger cognitive conflicts as a result of problems given to students (Fachrurazi 2011; Beneroso & Robinson, 2022; Umar & Ko, 2022, Kim et al., 2022). In this condition, students will utilize their cognitive abilities in an effort to find justification and confirmation of the knowledge in their minds.

Vygotsky argues that using thinking tools will lead to cognitive development in a person. Yuliani (2005: 44) specifically concludes that the uses of thinking tools according to Vygotsky are: helping solve problems, facilitating action, expanding abilities, and doing things with their natural capacity. This sociocultural learning theory is centered on the use of a person's thinking tools which cannot be separated from the influence of his socio-cultural environment. The socio-cultural environment will lead to increasingly complex capabilities possessed by each individual. This social construction theory emphasizes that human intelligence comes from society, environment and culture. The theory of cognitive socio-cultural also asserts that individual cognitive acquisition occurs first through interpersonal (interaction with the social environment) intrapersonal (internalization that occurs within oneself) (Malik & Ubaidillah, 2021).

The application of the ethnoscience approach can be learned to optimize all the possibilities that exist in students and find the concept for themselves. Students are more responsible for the learning process because they do more activities than just listening to information. By identifying local values and culture, using them as learning resources, integrating concepts or beliefs, and students who are rooted in indigenous (cultural) knowledge, can be trained to develop scientific thinking skills. According to Putri et al. (2014) learning through PBL applications based on local potential can help students discover the concepts they are learning for themselves. The role of the teacher is only limited to the role of the facilitator, providing direction and direction to students during learning.

Students' scientific thinking skills can emerge by applying an ethnoscience-based PBL model. Because each stage of the PBL model can develop scientific thinking skills, in addition to an ethnoscientific approach that can trigger students to think scientifically. This is also reinforced by the statement of (Imaningtyas et al., 2018) which states that through inquiry-based and problem-based learning activities, students can develop scientific thinking skills. These learning experiences can be in the form of opportunities to express opinions orally or in writing as well as observing phenomena that challenge scientific thinking skills. The learning using the PBL model with an ethnoscience approach can improve students' critical thinking skills in reproductive system material (Temuningsih, 2017; Suciyanti, 2021; Damayanti et al., 2017; Dewi et al., 2021). Ethnoscience-based PBL learning models are very effectively applied during the learning process because they can improve student learning outcomes. Furthermore, students' responses to learning with a problem-based learning model based on an ethnoscience approach which can train students in students' scientific thinking done through a student response questionnaire. Results student response questionnaire containing six statements are presented in Table 4.

**Table 4**. Response questionnaire results

| Statement | Percentage (%) | Category |
|---|---|---|
| Learning biology | 77,5% | Good |
| Matter of the reproductive system | 82,5% | Very good |
| Ethnoscience-based PBL model | 87,5% | Very good |
| Discussion activities | 82,5% | Very good |
| Student activity sheet | 82,5% | Very good |
| Evaluation | 80% | Good |
| Overall percentage (%) | 82,5% | Very good |

Based on Table 4 it can be seen that the value the average student response to learning by using the model ethnoscience-based PBL with a percentage of 82.5% is very criteria good. So thus learning is responded very well by students in the ongoing learning that they have followed. This is in line with proposed by Purnamasari et al. (2021) the ethnoscience-based PBL model very interesting, helps to understand the material more easily, and fits applied in learning.

Based on the student response indicators showed an interest in learning biology get a percentage 77.5% have good criteria. This shows that students' interest in Biology learning is moderate, there are students who like it learning Biology and there are students who are mediocre towards Biology learning. According to Marleni (2016) found that interest is one of the factors that can influence business people and the results achieved in an activity. Based on the second indicator, namely showing interest in reproductive system material obtains the percentage of 82.5% has very good criteria. The three indicators namely showed interest in the PBL-based learning model ethnoscience obtained a percentage of 87.5% with criteria very good. The fourth indicator is the discussion activity obtained a percentage of 82.5% with very good criteria. The fifth indicator on assignments which obtains a percentage of 82.5% has very good criteria. The sixth indicator to the evaluation of learning that is obtained the percentage of 80% has very good criteria. In line with the opinion of Sartika (2015) the higher the response given by students, the greater students like learning the. This is in line with the opinion of Majid (2013) stating that a good response is influenced by mastery of learning models and good classroom management by the teacher. When the teacher is able to manage the class properly, it will create optimal learning conditions. The previous study shown by Nurdiyansyah and Fariyatul (2013) that selection of the right model will give a good response and increase student activity in learning.

The results showed that there was an increase in students' scientific thinking skills which were good after applying ethnoscience-based learning with the problem based learning learning model. Problem-based learning is a learning method that places students at the center of learning through unstructured problem solving. Problem-based learning helps build knowledge when students activate prior knowledge in initial discussions. The steps of problem-based learning are to orient students to problems, organize students to learn, guide individual and group investigations, develop and present work results, and analyze and evaluate the solution process. The application of problem-based learning models can improve students' scientific thinking skills. Problem-based learning is a constructivist-based learning model that can help students improve their abilities. Besides that, it can also be used to stimulate students' interest in global issues and their surroundings. The problem-based learning model can train and help students' scientific thinking skills. The application of problem based learning learning models can significantly improve scientific thinking skills.

## 4. Conclusion

Based on the results of research regarding the effect of the ethnoscience-based problem based learning model on students' scientific thinking skills in reproductive system material, it can be concluded that there is a positive influence on scientific thinking skills using the ethnoscience-based. The researchers provide recommendations to biology teachers so they can consider using the ethnoscience-based PBL model in learning other than reproductive system material, because it has been proven to have a positive effect on students' scientific thinking skills. In addition, the weakness of my research is that it does not identify the potential of the environment that is used as a learning resource so that students do not get the ethnoscience that is appropriate to the material they are studying.

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