



Improving Students' Scientific Literacy and Cognitive Learning Outcomes through Ethnoscience-Based PjBL Model

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Abstract: Scientific literacy is one of the basic skills to compete in an increasingly competitive life. Nevertheless, Indonesian students continue to have low levels of scientific literacy. This study aims to determine the difference in students' scientific literacy and cognitive learning outcomes in the experimental and control classes and to find students' responses to the ethnoscience-based PjBL model in learning. This quasi-experimental research applies a non-equivalent control group design. The samples were eleventh-grade science students at SMA Negeri 2 Banjarmasin in the even semester of the 2021/2022 academic year. The data were collected using test and non-test methods. The instruments were scientific literacy and cognitive learning tests and a response questionnaire as a non-test instrument. The data were analyzed using descriptive and inferential analysis. The results showed significant differences in scientific literacy and cognitive learning outcomes between students in the experimental and control classes. The ethnoscience-based PjBL model gets a very good response. This study concludes that implementing the ethnoscience-based PjBL model can improve students' scientific literacy and cognitive learning outcomes. This study contributes to chemistry learning by improving scientific literacy and learning outcomes through the ethnoscience-based PjBL model.

Keywords: cognitive learning outcomes; colloids; ethnoscience; PjBL; scientific literacy

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INTRODUCTION

Education has an important role in equipping students to face future challenges, including the challenges of 21st-century learning (Ichsan et al., 2020). 21st-century learning, closely related to the industrial revolution 4.0, has a tremendous impact on education. Education is not limited to teaching knowledge but also ensures that students have various abilities (Yunianto et al., 2020). One of the essential abilities for students today is scientific literacy (Muliastri, 2020). Scientific literacy is one of the basic skills to compete in an increasingly competitive life (Kahler et al., 2020).

Scientific literacy, according to the Program for International Student Assessment (PISA), is the ability to engage in problems linked to science, use scientific knowledge, recognize problems, and develop conclusions based on the facts at hand (OECD, 2019). Scientific literacy is not limited to understanding science but understanding scientific processes and information in everyday life to the decision-making stage (Haerani et al., 2020). Therefore, scientific literacy in chemistry learning must be improved so that students not only understand chemistry as a concept but also understand and solve problems for modern society related to science and technology by applying chemistry (Ihsan & Jannah, 2021; Khery et al., 2020). Nevertheless, Indonesian students continue to have low levels of scientific literacy, as in the latest PISA results in 2018. Out of 78 countries, Indonesia is placed 70th in the scientific literacy category (Kahler et al., 2020; Sadoglu, 2018).

The importance of increasing scientific literacy is still not in line with current chemistry learning. Scientific literacy focuses on using scientific concepts in a meaningful way to build students' knowledge (Ihsan & Jannah, 2021; Jufrida et al., 2019; Khery et al., 2020). However, Dewi et al. (2021) stated that students are still not optimal in processing materials and information from teachers when learning chemistry in the classroom and implementing them in everyday life. Learning tools and questions in schools are also primarily not based on scientific literacy, so students are still not used to working on questions based on scientific literacy (Fuadi et al., 2020). Low scientific literacy indicates low cognitive learning outcomes because they have a positive relationship (Kulsum et al., 2020). Learning outcomes serve as a reflection of how well the learning process has progressed. If students' learning outcomes do not follow the minimum criteria, the learning is inadequate (Asy'syakurni et al., 2021; Wahyuni & Yusmaita, 2020). The low cognitive learning outcomes are caused by students' difficulty understanding abstract chemistry concepts and not applying these theories in real life (Pitnelly et al., 2021; Sutrisna, 2021).

One of the solutions to improve scientific literacy and cognitive learning outcomes is to use appropriate and innovative learning models. Project-based Learning (PjBL) model can provide a direct and learner-centered

experience. It facilitates students to gain knowledge and skills through involvement in project development and implementation. Projects with complex tasks will encourage students to design, solve problems, make decisions, and display products (Kulsum et al., 2020; Nugraha, 2022). Irfan (2019) added that in the PjBL model, students can convey and realize their ideas to provide a positive stimulus in finding new concepts.

Besides the learning model, an approach also affects learning quality. One scientific approach that can improve scientific literacy and learning outcomes is ethnoscience (Wiradintana, 2018). Ethnoscience is the knowledge that comes from culture and is part of a society with a science concept (Suswati, 2021). We can find this knowledge in the language, customs, traditional food, moral values, habits, rules, and prohibitions on technology created in a society with scientific knowledge (Nuralita, 2020). In education, ethnoscience learning can be a breakthrough that combines culture with science in the learning process. The application of ethnoscience-based learning will strengthen students' understanding of science concepts because they study culture and local wisdom to reveal the scientific knowledge in it (Lathifah et al., 2019). In addition, students can apply the concept of science and connect the material with community knowledge so that scientific literacy will also increase (Ulfah et al., 2020; Zannatunna'imah et al., 2021).

Several studies have demonstrated the effectiveness of implementing the PjBL model in learning. Nuraini and Waluyo (2021) concluded that students' learning outcomes can be greatly improved by implementing the PjBL model. That is in line with Hamidah et al. (2021), which shows significant differences in knowledge-learning outcomes by applying the PjBL model. Anggreni et al. (2020) and Hasbie et al. (2018) showed that scientific literacy in students is influenced by the PjBL model. Other studies also showed the effectiveness of ethnoscience-based learning, such as Sholahuddin et al. (2021) and Wibowo and Ariyatun (2020). Wulandari et al. (2018) concluded that ethnoscience-based chemistry learning can improve scientific literacy skills. Nuralita (2020) and Winarti et al. (2018) showed that ethnoscience-based learning significantly affects cognitive learning outcomes.

One chemistry material with an abstract concept in the form of memorization is the colloidal system. This colloidal system is very close in everyday life. If it is studied more deeply, colloids will provide many benefits and wide applications in various fields in everyday life (Falah et al., 2018; Hau et al., 2021). Students will find it easier to understand colloids and obtain complete concepts through active, attractive, and student-centered learning (Mirnawati et al., 2021).

Based on the previous description, previous studies have examined the use of PjBL models or ethnoscience-based learning on scientific literacy or learning outcomes. However, research on using the ethnoscience-based PjBL model to improve scientific literacy skills and cognitive learning outcomes has yet to be found. Therefore, this study aims to determine the difference in students' scientific literacy and cognitive learning outcomes in the experimental and control classes and to find out students' responses to the ethnoscience-based PjBL model in learning.

METHODS

This quasi-experimental research applies a non-equivalent control group design. In this study, the experimental group applied the ethnoscience-based PjBL model and the control group applied the discovery learning model.

Population and Sample

The population in this study were eleventh-grade science students at SMA Negeri 2 Banjarmasin in the even semester of the 2021/2022 academic year. Purposive sampling was deployed to choose two classes for the samples: class XI MIPA 1 served as the experimental class, while class XI MIPA 4 served as the control class. There are 33 students in each class.

Data Collection

The data were collected using test and non-test methods. The test instrument was a scientific literacy test with eight essay questions and a cognitive learning test with ten multiple-choice questions. The test questions passed the eligibility tests for validity, reliability, level of difficulty, and discrimination. The non-test instrument was a response questionnaire with 10 statement items.

Data Analysis

The data in this study were analyzed using descriptive and inferential analysis. Descriptive analysis was used to analyze scientific literacy, cognitive learning outcomes, and students' responses. The study results in the form of pre-test and post-test data were processed into N-gain (Wibowo & Ariyatun, 2020) to determine the extent to which students experienced increased scientific literacy and cognitive learning outcomes. The overall normalized N-gain obtained is categorized as in Table 1.

Table 1. Category of the normalized gain

Gain index	Category
$g \leq 0,3$	Low
$0,3 < g \leq 0,7$	Moderate
$g > 0,7$	High

Data on students' responses to the application of the ethnoscience-based PjBL model was measured by a response questionnaire. Students' response scores are described using the category in [Table 2](#).

Table 2. Category of Students' Response

Score	Category
42 – 50	Very good
34 – 41	Good
26 – 33	Enough
18 – 25	Less
10 – 17	Poor

The inferential analysis, including the normality test, homogeneity test, and t-test, was used to analyze differences in scientific literacy and cognitive learning outcomes. If $t\text{-count} > t\text{-table}$, there is a significant difference between students' average scores in the experimental and control classes. %.

RESULT AND DISCUSSION

Scientific Literacy

The N-gain data showing an increase in the scientific literacy scores of the experimental and control class students are in [Table 3](#).

Table 3. N-gain for scientific literacy data

Class	Result	Average	N-gain	Category
Experimental	Pre-test	28,79	0,74	High
	Post-test	80,18		
control	Pre-test	29,55	0,62	Moderate
	Post-test	71,34		

The independent t-test for normality and homogeneity of scientific literacy data of the experimental and control class are in [Table 4](#).

Table 4. Independent T-test of Scientific Literacy Data

Data	Class	db	$\bar{X}$	SD^2	t_{count}	$t_{\text{table 5\%}}$	Conclusion
Pre-test	Experimental	64	28,79	251,05	0,19	2,00	No different
	Control	64	29,55	246,71			
Post-test	Experimental	64	80,18	126,99	2,85	2,00	Significantly different
	Control	64	71,34	180,94			

[Table 3](#) shows that the experimental class that applied the ethnoscience-based PjBL model had a more significant increase in scientific literacy scores than the control class. [Table 4](#) shows significant differences in scientific literacy in the experimental and control classes. Based on these data, it can be concluded that learning using an ethnoscience-based PjBL model can improve scientific literacy. The different treatment used in the control and experimental classes resulted in different increases in students' scientific literacy. Through the development and implementation of projects, the PjBL model in the experimental class encourages students to actively participate in the learning process. By being involved on difficult assignments, students will learn new things. [Anggreni et al. \(2020\)](#) also showed that using the PjBL model increases students' scientific literacy because their involvement will train them to identify scientific issues, explain scientific phenomena, and use scientific evidence.

The integration of ethnoscience in the experimental class also affects scientific literacy. Through ethnoscience-based projects, students are encouraged to analyze traditional food projects to find hidden colloid knowledge, so they can build chemistry concepts on colloid materials to become real and improve scientific literacy. These results were in line with [Ningsih et al. \(2018\)](#), who showed that using the PjBL model and integrating traditional food ethnoscience significantly increase scientific literacy. Students can build abstract colloid knowledge into reality and make connections between colloid concepts to provide a meaningful learning

experience. The comparison of students' scientific literacy of each indicator is presented in Figure 1.

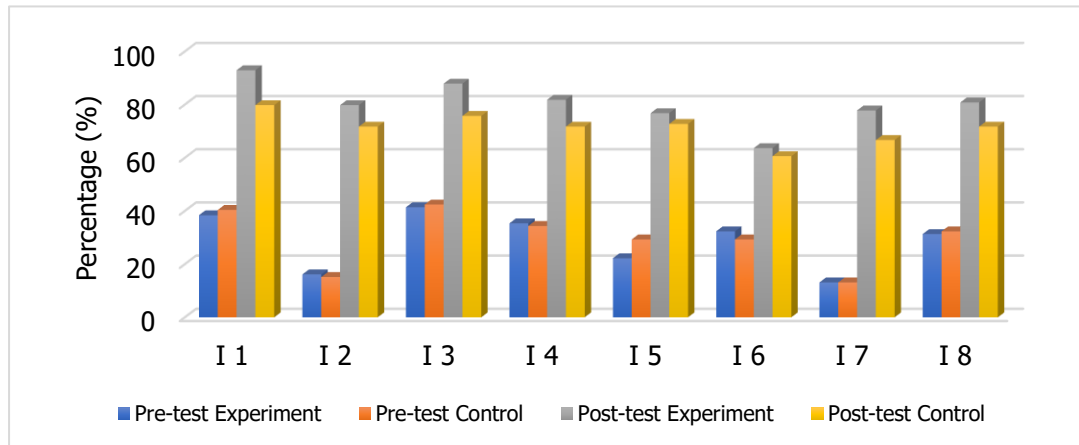


Figure 1. The Comparison of Students' Scientific Literacy in Each Indicator

Note:

I 1: Recall and apply appropriate scientific knowledge

I 2: Identify, use, and generate explanatory models and representations

I 3: Identify the question explored in a given scientific study

I 4: Propose ways of exploring a given question scientifically

I 5: Evaluate ways of exploring a given question scientifically

I 6: Describe and evaluate a range of ways that scientists use to ensure the reliability of data and the objectivity and generalize explanations

I 7: Transform data from one representation to another

I 8: Analyze and interpret data and draw appropriate conclusions

The findings show that both classes experience the highest achievement percentage in indicator 1 than other indicators. This finding is in line with Sholahuddin et al. (2021), who showed that the indicators of remembering and applying appropriate scientific knowledge in both classes have the highest achievement compared to other scientific literacy indicators. Indicator 6 gets the lowest percentage compared to other indicators. It means that students still have difficulty in describing and evaluating the various methods used by scientists to ensure the validity and objectivity of data and generalize explanations. This result aligns with Sari et al. (2017), who showed that this indicator has the lowest percentage of indicator achievement compared to other indicators on the competence to evaluate and design scientific investigations.

Cognitive Learning Outcomes

The N-gain data showing an increase in the cognitive learning outcomes of the experimental and control class students are presented in Table 5.

Class	Data	Average	N-gain	Category
Experimental	Pre-test	38,79	0,82	High
	Post-test	88,18		
Control	Pre-test	39,09	0,73	High
	Post-test	82,12		

The independent t-test for normality and homogeneity of cognitive learning outcomes data of the experimental and control class are presented in Table 6.

Data	Class	db	$\bar{X}$	SD^2	t_{count}	$t_{table 5\%}$	Conclusion
Pre-test	Experiment	64	38,79	217,23	0,08	2,00	No different
	Control	64	39,09	189,77			
Post-test	Experiment	64	88,18	102,84	2,34	2,00	Significantly different
	Control	64	82,12	110,98			

Table 5 shows that the experimental class that applied the ethnoscience-based PjBL model had a more significant increase in cognitive learning outcomes than the control class. Table 6 shows that cognitive learning outcomes significantly differed in the experimental and the control classes. Based on these data, it can be concluded that learning using the ethnoscience-based PjBL model can improve cognitive learning outcomes. This study result is in line with Mukti et al. (2020), who showed that the average learning outcomes in the class applying the PjBL model are higher than in the class applying discovery learning. Research by Muliaman and Mellyzar (2020) also showed that learning outcomes from using the PjBL model increased significantly and obtained a higher average increase than the control class. Another study by Wulandari et al. (2018) also showed that ethnoscience-based learning improves students' learning outcomes.

In the PjBL model, students construct their knowledge through involvement in project completion close to everyday life. Muliaman and Mellyzar (2020) stated that using the PjBL model will encourage students to connect concepts or subject matter in everyday life, increase their activeness during the learning process, increase motivation, and develop teamwork so that their cognitive learning outcomes also increase. The integration of ethnoscience in the experimental class also affects cognitive learning outcomes. Through ethnoscience-based projects, students' understanding will increase because linking the knowledge in the making traditional food project with scientific knowledge can strengthen students' understanding, so cognitive learning outcomes will also increase. The comparison of students' cognitive learning outcomes for each indicator are illustrated in Figure 2.

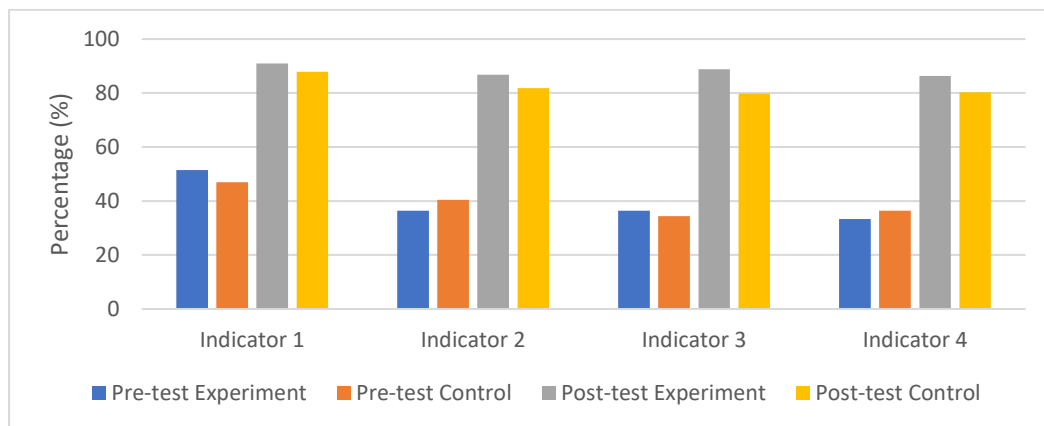


Figure 2. The comparison of Students' Cognitive Learning Outcomes in Each Indicator

Note:

Indicator 1: Distinguish solution, colloid, and suspension

Indicator 2: Classify the type of colloid by dispersed phase and medium

Indicator 3: Analyze colloid properties in daily life

Indicator 4: Explain how colloid is formed

The findings show that the experimental class has a higher achievement percentage of indicators than the control class. The indicator of distinguishing solutions, colloids, and suspensions has the highest achievement percentage, while the indicator of explaining how colloids are formed has the lowest.

Students' Response

Student response questionnaires were given at the end of the lesson. This questionnaire determines the extent to which students' interest and acceptance of the application of the ethnoscience-based PjBL model in the experimental class and the discovery learning model in the control class. The average of students' responses in the experiment and control class is presented in Table 7.

Table 7. The Average of Students' Response

Class	Average score	Category
Experiment	43,27	Very good
Control	39,94	Good

Student responses were classified into positive responses for students who gave answers strongly agree and agree, neutral responses for students who gave hesitant answers, and negative responses for students who gave answers disagree and strongly disagree. The difference in the percentage of students' responses in the experimental and control classes is illustrated in Figure 3.

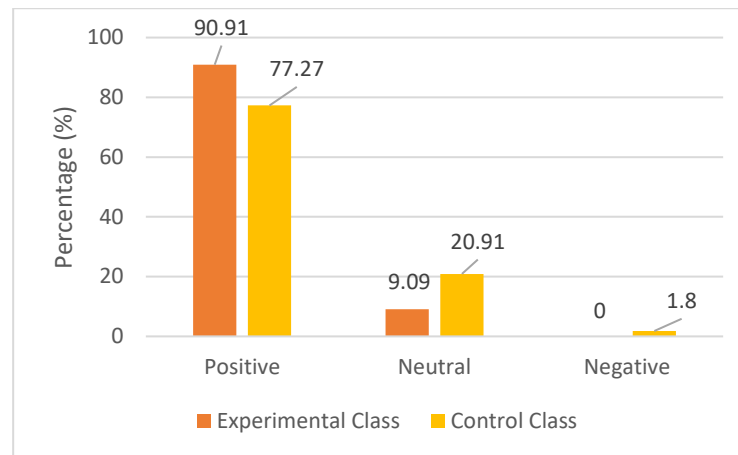


Figure 3. Percentage of Students' Response

Table 7 shows that the experimental class students gave response to learning using the ethnoscience-based PjBL model in the very good category. Meanwhile, the control class students gave a response in the good category. Figure 3 shows that the experimental class students' positive response to using the ethnoscience-based PjBL model has a higher percentage than the control class. Students' very good response to learning using the ethnoscience-based PjBL model is in line with the research by Ardianti and Raida (2022), who stated that the ethnoscience-based PjBL model has a positive response with an average score of 89.60% in the very good category.

Learning using the PjBL model can encourage students to participate actively in project activities (Anggreni et al., 2020). Using this PjBL model can make students active and creative in completing projects with their groups (Birdman et al., 2022; Lestari & Juanda, 2019). The use of ethnoscience is also a breakthrough that combines culture with science in the learning process so that students are interested in learning because it is close to life (Mirnawati et al., 2021; Nuralita, 2020). In addition, learning that uses an ethnoscience-based PjBL model by elevating local culture and wisdom makes learning more meaningful and can expand students' knowledge so that the learning process becomes attractive and fun (Ardianti & Raida, 2022; Nuralita, 2020). From these results, students are excited to learn using the ethnoscience-based PjBL model, so it is hoped that teachers will use it on other materials.

CONCLUSION

A project-based learning model allows students to build their knowledge through project completion. Using ethnoscience also allows students to deepen their knowledge, apply scientific concepts, connect culture and community knowledge with science, and enhance their understanding of science concepts. Based on the study results, students' scientific literacy and cognitive learning outcomes are significantly different between the experimental class applying ethnoscience-based PjBL models and the control class applying discovery learning models. The study also found that the ethnoscience-based PjBL model gets a very good response from students. This study suggests that educational practitioners use the ethnoscience-based PjBL model in learning to improve students' scientific literacy and cognitive learning outcomes so that it has a good impact on the learning process, especially in chemistry learning. Further research is expected to apply the ethnoscience-based PjBL model to other materials.

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