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The Ethnoscience-Based Project Based Learning Model on Learning Outcomes and Scientific Literacy

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ABSTRACT

Many students struggle to understand science because it's too abstract and removed from life. Despite their scientific value, local wisdom and traditional knowledge are typically neglected as learning resources. The connection between universal science and local cultures is referred to as ethnoscience. In ethnoscience-based PjBL, students learn theory and observe how science applies to their culture. Therefore, this study intends to determine and describe the effect of the ethnoscience-based project-based learning (PjBL) learning model on learning outcomes and scientific literacy. This study uses quantitative research with ex post facto research method. The subjects of this study were class VII students of Middle School 4 Palimanan, Cirebon Regency. Data collection uses questionnaires, observations, and test questions with a total of 30 items, and the number of samples (respondents) used is 60 students. The results of this study indicate that the application of the ethnoscience-based project-based learning model positively affects the learning outcomes of class VII students in science subjects, as evidenced by a calculated t value of 4.637 compared to a t table value of 1.672, resulting in an influence of 25.8%, while the remaining 74.2% is affected by other unexamined variables. Similarly, the application of the ethnoscience-based Project Based Learning model enhances the scientific literacy of seventh-grade science students. The influence is shown based on the calculated t value of 7.537 > t table = 1.672, with a 48.6% effect, while the remaining 51.4% is influenced by other variables not examined in this study. This research will produce a structured ethnoscience-based PjBL learning model that can be used as a guide for teachers.

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1. INTRODUCTION

Ethnoscience is a strategy for creating a learning environment and designing learning experiences that integrate culture as part of the science learning process (Hikmawati et al., 2021; Sari et al., 2023). Ethnoscience is implemented in science learning by incorporating the culture that develops in society into the learning process (Rayis et al., 2023; Efendi & Muliadi, 2023). Active involvement in learning fosters values instilled

through life experiences and empathy for the environment. Thus, teachers not only convey theory but also transfer the values learned from learning activities through character education (Walker et al., 2015; Sakti et al., 2024). Character formation occurs when teachers connect learning materials to students' daily lives. Based on the above considerations, it is necessary to develop a learning method that fully engages students so that learning activities are not dominated by certain students. Furthermore, through the selection of this learning method, it is hoped that the source of information received by students is not only from the teacher but also can increase student activeness in learning and analyzing existing knowledge (Sukackė et al., 2022).

One strategy that can be implemented to address this problem is prioritizing the Project-Based Learning (PjBL) model. Project-Based Learning (PjBL) model is an innovative learning model that emphasizes contextual learning through complex activities that engage students in the learning process, enabling them to solve problems holistically, construct their thought patterns, and find solutions independently and realistically (Hussein, 2021; Maros et al., 2023; Perifanou & Economides, 2025). Projects completed by students will make them more skilled, creative, competent, and confident in processing and drawing conclusions from practical projects (Kong et al., 2024). Based on this, it is highly likely that students will be more focused and enthusiastic in learning, fostering creativity and becoming more active in participating in each teaching and learning process. This will undoubtedly impact students' ability to receive and understand the lessons taught by teachers in the classroom. The better the students' acceptance and understanding, the more likely they are to influence their learning outcomes (Park et al., 2014; Pérez-Pérez et al., 2020).

The application of the Project-Based Learning (PjBL) model in science subjects will be more effective and maximized in improving student learning outcomes if the learning model is based on ethnoscience (Ardianti et al., 2022; Hidayah et al., 2024). The implementation of the ethnoscience-based Project Based Learning (PjBL) model provides opportunities for students to connect scientific concepts to everyday life. As Mardianti et al. (2020) also emphasized, "learning using an ethnoscience approach will actively engage students in learning, resulting in a better understanding than conventional learning." The implementation of the ethnoscience-based Project Based Learning (PjBL) model not only improves student learning outcomes in science subjects but also has a broader impact, maximizing the development of students' scientific literacy skills. Scientific literacy is one of the 16 essential skills for the 21st century established by the WEF (World Economic Forum) (Kennedy & Sundberg, 2020; Putri & Mufit, 2023). Scientific literacy is the ability to understand scientific concepts and processes and utilize them to solve problems in everyday life (Valladares, 2021).

This skill is crucial because it provides a context for addressing social issues. A person with scientific literacy skills is considered better able to handle everyday problems and make good decisions based on the information they obtain (Yacoubian, 2018; Sharon & Baram-Tsabari, 2020; Fortus et al., 2022). Furthermore, according to Mijaya et al. (2019), "*the 21st century is also highly competitive; therefore, scientific literacy skills must be developed from an early age*." There are at least several reasons

why scientific literacy is important: an understanding of science allows for the fulfillment of personal needs and the joy of being shared with others.

The application of the Project Based Learning (PjBL) model based on ethnoscience is considered very appropriate for improving students' scientific literacy skills in science subjects. As in the study by Kamariah et al. (2024), there is an effect in the use of the project-based learning model on students' scientific literacy. This relevant research states that the use of an appropriate learning model will affect scientific literacy in students, where an interesting learning model is needed, one of which is the project-based learning model that uses problems as the first step in learning.

A preliminary study by the author with observations revealed problems in the science teaching process in class. Interviews with science teachers at Middle School 4 Palimanan revealed that teachers frequently use the ethnoscience-based Project-Based Learning (PjBL) model as a solution to increase student engagement. In this context, science teachers frequently engage students in various activities that engage them in learning through class projects or study groups. In other words, the implementation of the learning model aligns with the syntax of ethnoscience-based Project-Based Learning (PjBL). Furthermore, during interviews, teachers observed that during the learning process, they frequently pay attention and allow students time to ask questions and express their opinions. However, according to a science teacher, many students are still less active in participating in the learning process using the ethnoscience-based Project Based Learning (PjBL) model. This has impacted the learning outcomes of seventh-grade students in science, which remain low. This average score falls short of the school's minimum completion criteria of 70. This is due to various factors, including a lack of active student engagement in the learning process. Then the teacher argued that in addition to the lack of student activity in learning, which caused the low learning outcomes, students were also not yet capable enough of working on science literacy questions in science subjects, and the learning and discussion did not run optimally because of the lack of enthusiasm of students interested in learning, who relied more on friends who had higher abilities to do assignments or questions. This caused other students who tended to have fewer or low abilities to only become followers. The teacher also stated that many obstacles remained in improving science literacy through learning activities; they focused on questions testing memory and comprehension rather than applying science literacy questions. In addition, there was also a lack of awareness of students in developing their potential to process information and relate it to their knowledge and the real world.

The results of students' scientific literacy are still relatively low, as each of the five tested indicators has an average score below 50%. Additionally, one of the causes is the low ability of students to answer questions. The average results for the indicators are as follows: understanding phenomena at 33%, identifying scientific problems at 32%, explaining scientific phenomena at 29%, using scientific evidence at 29%, and internalizing the field of application personally, socially, or globally at 36%. The thing that causes low scientific literacy in students is suspected to be due to their inability to search for or process information and relate it to existing knowledge. This study aims to

describe how the Project-Based Learning (PjBL) model, which is based on ethnoscience, affects learning outcomes and scientific literacy in students.

This research not only measures cognitive learning outcomes but also the impact on scientific literacy. Scientific literacy encompasses the ability to understand scientific concepts, use the scientific process, and think critically to make decisions. With ethnoscience-based PjBL, students not only memorize theories but also learn how to connect local knowledge with universal scientific concepts, thus deepening their understanding of scientific literacy. This helps them see the relevance of science in their daily lives and culture.

2. METHOD

This research approach is quantitative. It uses an ex post facto research method. Ex post facto research is a systematic empirical investigation in which scientists do not directly control independent variables because their existence has already occurred or because they are inherently non-manipulable. Relationships between variables are established based on differences that accompany the independent and dependent variables without direct intervention. This study does not involve any direct manipulation or treatment of the independent variables. The research is conducted on activities and events that have already taken place or occurred. In this study, there are three variables: the ethnoscience-based Project Based Learning (PjBL) model as the independent variable (X), student learning outcomes as the first dependent variable (Y1), and student scientific literacy as the second dependent variable (Y2). This study aims to determine the effect of the ethnoscience-based Project Based Learning (PjBL) model on the learning outcomes and scientific literacy of seventh-grade students at Middle School 4 Palimanan, Cirebon Regency, in science. For more details on the research design used in this study, see the following figure 1.

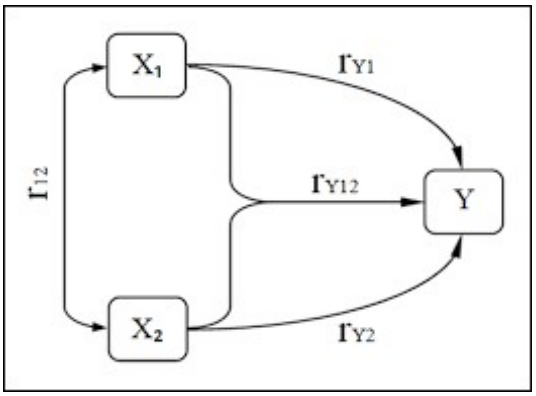

Figure 1. Research Design

Description:
X = Project-Based Learning (PjBL) Model Based on Ethnoscience
Y1 = Student Learning Outcomes

Y2 = Student Scientific Literacy

The population in this study was all 7th grade students of SMP Negeri 4 Palimanan, Cirebon Regency, consisting of 140 students. In this study, the researcher used probability sampling. In this study, the researcher used simple random sampling. The required sample size was 60 students.

The instruments used in this study include open module, observation, the tests used in this study were science ability tests and science literacy tests for seventh-grade students at Middle School 4 Palimanan, Cirebon Regency. The questionnaire used in this study was a questionnaire regarding the implementation of the ethnoscience-based Project Based Learning (PjBL) model.

The data analysis procedures used included the Data Validity Test: Furthermore, to reveal the validity of the data, the researcher will use SPSS version 27 for Windows. Examining the significance value between the total variable and the variable in each question reveals the validity of each question. The significance value of the correlation between the total variable and each question variable is below the alpha value (0.05), thus concluding that all question variables are valid. Data Reliability Test: The statistical test used is Cronbach's Alpha, where a variable is considered reliable if it produces a Cronbach's Alpha value > 0.60." Data Normality Test: Regarding the transmission of data normality, the researcher used a conversion program with SPSS version 27 for Windows, with the decision rule that if $p \geq 0.05$, the data can be declared normally distributed. Multicollinearity Test: To determine the presence or absence of multicollinearity in the regression model, the tolerance value and its opposite, the Variance Inflation Factor (VIF), are examined. Commonly used thresholds for multicollinearity are a tolerance value <0.10 or a VIF >10. Data testing was performed using the SPSS (Statistical Product and Service Solution) version 27.0 software package. Autocorrelation Test: "The autocorrelation test is used to determine whether there is a correlation between the error confounding factor in period t and the previous period t-1 in the linear regression model. In this study, the Durbin-Watson test (DW test) was used (Ghozali, 2020).

Simple Regression Analysis: To calculate the effect of variable X on variable Y, the following regression equation formula is used:

$\bar{Y}=a+bx$

Where:

Y = dependent variable
X = independent variable
a = intercept value (constant)
b = regression directional coefficient

Next, in calculating the regression values, the researcher used SPSS for Windows version 27 to interpret the r value. The r value is no more than ($-1 \leq r \leq +1$). If r = -1,

the correlation is perfectly negative; r = 0, the correlation is zero; and r = 1, the correlation is very strong.

Table 1. Interpretation of Correlation Coefficient r Value

No.	Correlation Interval	Relationship Level
1	0,80 – 1,000	Very Strong
2	0,60 – 0,799	Strong
3	0,40 – 0,599	Fairly Strong
4	0,20 – 0,399	Low
5	0,00 – 0,199	Very Low

The hypothesis test used was the t-test to determine the effect of the independent variable on the dependent variable. For further calculations, the researcher used SPSS for Windows version 27. To determine whether H0 was rejected or accepted, the calculated t value was compared with the t table. The test criteria are as follows:

a. If the calculated t value is greater than the t table, then H0 is rejected and Ha is accepted, meaning that statistically, variable X influences variable Y.
b. If the calculated t value is less than the t table, then H0 is accepted and Ha is rejected, meaning that statistically, variable X has no effect on variable Y.

3. RESULTS AND DISCUSSION

Results

In this study, the project-based learning (PjBL) model was applied based on ethnoscience. Ethnoscience-based learning integrates elements of local wisdom within the context of culture, customs, and works that are prevalent in society. This creates a fusion of learning and local wisdom within the community, making it part of the educational and learning process for students.

The Javanese specialty, klepon, is a traditional food that can be associated with science education. Ethnoscience, as the approach used in this research, is making klepon, applying the topic of heat. Klepon is a familiar market snack that is frequently encountered by students. The process of making klepon involves heat, specifically the transformation of brown sugar from a solid to a liquid state when the klepon is cooked; this phenomenon is known as melting because it requires heat. Then, when the water is boiled to boil the klepon, the phase changes from liquid to vapor/gas, a process that requires heat. Then, when the klepon is boiled and nearly cooked, we observe the klepon expanding with an up-and-down movement, a phenomenon called convection.

Klepon is associated with the concepts of temperature, heat, and heat transfer. In the process of making klepon, we can see the concepts of temperature, heat, and heat transfer during the boiling process. When making and cooking klepon, the klepon is boiled in boiling water because it requires a high temperature. After the klepon is added, the heat from the water is transferred to the klepon, causing the water temperature to drop, leaving the klepon below the surface. After boiling again, the klepon will rotate and move up and down. Once cooked, the klepon will rise to the surface or float, allowing the study of heat and its transfer to relate to the topic of convection heat transfer.

Before boiling, the klepon filling is solid palm sugar, but after boiling, the palm sugar melts, thus linking it to the relationship between heat and changes in state. The palm sugar in the klepon filling undergoes a phase change from solid to liquid due to the change in temperature. This melting process requires heat to transform the palm sugar. The brown sugar in the klepon changes from solid to liquid once it is cooked. The following steps illustrate the klepon-making process:

1. Steam the grated young coconut for approximately 20 minutes to prevent the coconut from spoiling quickly.
2. Combine the glutinous rice flour, rice flour, and pandan paste in a bowl. Stir well while gradually adding water.
3. Continue kneading the dough until it can be plied. Don't make it too soft, as the klepon will fall apart, and don't make it too dry, as the brown sugar will leak out easily.
4. Take a small amount of dough, flatten it, and fill the center with a sufficient amount of grated brown sugar. Then, form balls. Repeat this process until the dough is used up.
5. In a saucepan, bring to a boil over high heat, add the glutinous rice balls, and cook until they float. Once they float, the klepon are done.
6. Remove from heat and drain. Then, roll them in the grated coconut (you can also add a little salt to it for a more savory flavor).

Meanwhile, the relationship between making traditional klepon and the topic of heat in the seventh-grade science course at Middle School 4 Palimanan, Cirebon Regency, is as follows:

1. The klepon must be added to the water only after it is already boiling. When the klepon is placed in boiling water, the water temperature drops and then returns to a boil after a while. This condition occurs due to the presence of heat. The heat from the boiling water is transferred to the klepon, allowing it to cook slowly. During boiling, heat transfer occurs by convection, with the klepon experiencing up-and-down rotation. Once cooked, the klepon floats.

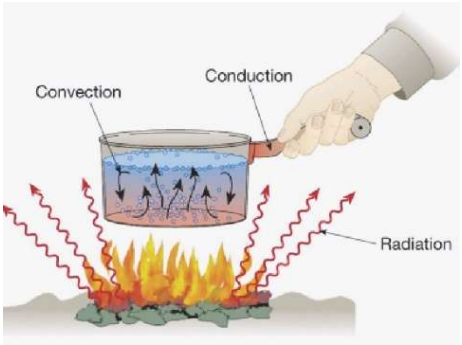

Figure 2. Heat Transfer in Boiling Water

2. The grated coconut used must be steamed first to prevent the klepon from spoiling quickly. Steaming the grated coconut at a high temperature of 65°C kills any

bacteria present in the grated coconut. This eliminates bacteria, making the grated coconut last longer, preventing the klepon from drying out quickly.

3. The klepon should be round with a small diameter (approximately 1.5 cm - 3 cm). A round shape with a diameter of approximately 1.5 cm - 3 cm affects the cooking time of the klepon. An even, round shape with a small diameter allows heat to quickly transfer to the klepon at a high temperature.
4. When boiling, klepon will feel hot when near the stove. The heat from the flame when the stove is turned on transfers heat to the skin, and the body feels the heat; thus, this phenomenon is called radiant heat transfer.

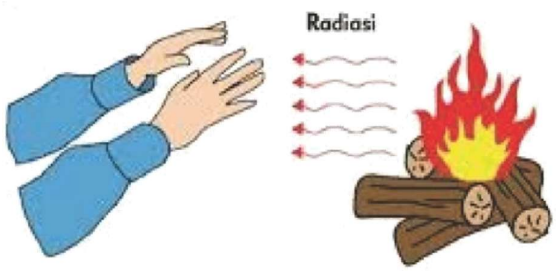

Figure 3. Heat Transfer by Radiation

5. The palm sugar filling in the klepon will melt after being boiled. The palm sugar filling undergoes a change in state due to the high temperature, changing from a solid to a liquid, a phenomenon known as melting. The heat in the boiling water will transfer to the palm sugar through the outer skin of the klepon, causing the sugar filling to melt.

Figure 4. Brown Sugar in Klepon Melts Due to Heat Transfer

6. Glutinous rice flour must be used to make klepon. Glutinous rice flour has a high amylopectin content of 99.11% and is more resistant to freezing and melting than other flours.

The Effect of Implementing the Ethnoscience-Based Project-Based Learning (PjBL) Model on Learning Outcomes

The implementation of the ethnoscience-based Project-Based Learning (PjBL) model at Middle School 4 Palimanan in Cirebon Regency had a 25.8% positive impact on the science learning outcomes of seventh-grade students, indicating a strong effect. This means that if the implementation of the ethnoscience-based Project-Based

Learning (PjBL) model is further enhanced, it will contribute to improved student learning outcomes. Other variables not examined in this study influence the remaining 74.2%, as indicated by the 25.8% effect size.

Likewise, based on the results of the research hypothesis, it is proven that the ethnoscience-based Project Based Learning (PjBL) learning model has a p-value (sig.t) of 0.000 < 0.05, indicating significance, with a calculated t value of 4.637 > t table = 1.672. This means that the ethnoscience-based Project Based Learning (PjBL) learning model has a significant influence on student learning outcomes in science subjects in grade VII of middle school 4 Palimanan, Cirebon Regency.

The Effect of Implementing an Ethnoscience-Based Project-Based Learning (PjBL) Model on Students' Scientific Literacy

As previously explained, this study not only analyzes and describes the effect of implementing an ethnoscience-based Project-Based Learning (PjBL) model on student learning outcomes but also analyzes its impact on the scientific literacy skills of seventh-grade science students at Middle School 4 Palimanan, Cirebon Regency.

Building upon data analysis conducted by the researcher using SPSS for Windows version 27, the results indicate that the implementation of an ethnoscience-based Project-Based Learning (PjBL) model has a strong influence on students' scientific literacy skills in seventh-grade science at Middle School 4 Palimanan, Cirebon Regency. The effect is 48.6%, with the remaining 51.4% being influenced by other variables not examined in this study.

Meanwhile, based on the results of the hypothesis test, it was found that the ethnoscience-based Project Based Learning (PjBL) learning model variable had a t-value of 7.537 > t-table = 1.672, categorized as significant. These results indicate that the ethnoscience-based Project Based Learning (PjBL) learning model has a significant influence on students' scientific literacy in science subjects in grade VII of Middle School 4 Palimanan, Cirebon Regency.

Discussion

Ethnoscience-based learning integrates elements of local wisdom within the context of culture, customs, and works that are generally developed within society. This creates a fusion of learning and local wisdom within the community, making it part of the educational and learning process for students. As emphasized by Zidny et al. (2020), Mukti et al. (2022), "*One cultural element that can be integrated into science learning is the community's knowledge system, also known as ethnoscience (indigenous science)*." Science (natural sciences) and ethnoscience (indigenous science) are two different things (Parmin & Fibriana, 2019). Science is a body of knowledge systematically acquired using scientific methods. Ethnoscience, on the other hand, is community knowledge as a socio-cultural construct acquired through various means, both scientific and non-scientific (Fasasi, 2017).

Meanwhile, in this study, ethnoscience in science learning is applied to traditional foods. The traditional food used as the object of learning is a dish called klepon. In this

learning process, students use the Project-Based Learning (PjBL) model combined with the concept of ethnoscience, and the project is making the traditional food klepon. The seventh-grade science subject, which focuses on heat, closely influences the choice of klepon. The implementation of an ethnoscience-based Project Based Learning (PjBL) model, focusing on making traditional klepok, aims to determine the contribution of learning to student learning outcomes in science subjects in grade VII of Middle School 4 Palimanan, Cirebon Regency, specifically regarding heat. This serves as the basis for determining the effects of the learning, namely whether or not it influences learning outcomes. Student learning outcomes are the abilities children acquire after undergoing learning activities. Learning itself is a process in which someone strives to achieve a relatively permanent change in behavior.

The ethnoscience-based Project-Based Learning (PjBL) methodology at Middle School 4 Palimanan in Cirebon Regency improved seventh-grade science learning by 25.8%. This suggests that improving the ethnoscience-based Project-Based Learning (PjBL) paradigm will improve student learning. Due to the 25.8% effect size, other variables not studied in this study affect the remaining 74.2%. The research hypothesis reveals that the ethnoscience-based Project Based Learning (PjBL) model has a significant p-value (sig.t) of $0.000 < 0.05$, with a computed t value of $4.637 >$ t table $= 1.672$. This result means that the ethnoscience-based Project Based Learning (PjBL) learning paradigm affects science learning results in grade VII of middle school 4 Palimanan, Cirebon Regency.

In addition to examining the impact of the ethnoscience-based Project Based Learning (PjBL) model on student learning outcomes, this study also analyzes and describes its impact on students' scientific literacy skills. Students' scientific literacy in science subjects is the ability to analyze, connect, and explain in a structured manner various phenomena occurring during the learning process, particularly those directly related to the subject matter of heat, implemented through collaborative (group) project activities (Bellová, 2018). In this activity, each group created a traditional klepon food project. Scientific literacy is the ability of an individual to use their scientific knowledge to identify problems encountered in everyday life, draw conclusions from them, and make decisions regarding the universe and the changes caused by human activities.

The results show that an ethnoscience-based Project-Based Learning (PjBL) paradigm improves seventh-grade science students' scientific literacy at Middle School 4 Palimanan, Cirebon Regency. The effect is 48.6%, with 51.4% influenced by variables not studied. The hypothesis test indicated that the ethnoscience-based Project Based Learning (PjBL) learning model variable had a significant t-value of $7.537 >$ t-table $= 1.672$. These findings suggest that the ethnoscience-based Project Based Learning (PjBL) learning paradigm improves science literacy in grade VII of Middle School 4 Palimanan, Cirebon Regency.

If we apply the learning concept effectively, the ethnoscience-based Project Based Learning (PjBL) model will optimally develop students' scientific literacy skills (Rahman et al., 2023; Rusmansyah et al., 2023; Hidayah et al., 2024). This is justified by the advantages of the project-based learning (PjBL) model, which include improving

problem-solving skills, training students to broaden their thinking, fostering interest in learning, and ultimately enhancing critical and creative thinking skills (Miranda et al., 2020; Sucilestari et al., 2023). Through the advantages of the Project Based Learning (PjBL) model, which is then applied using ethnoscience concepts in making traditional klepon food, students will be more motivated to develop their thinking skills and concepts, thereby maximizing their ability to apply scientific literacy.

Research Contributions

1. Learning Model Development: This research will produce a structured ethnoscience-based PjBL learning model that can be used as a guide for teachers.
2. Cultural Relevance: Demonstrates that science learning does not have to be separate from culture but can be integrated to enrich students' understanding.
3. Improving Science Literacy: Provides empirical evidence on how a contextual approach can effectively improve students' science literacy.

4. CONCLUSION

The conclusion of this study shows that the implementation of the ethnoscience-based Project Based Learning (PjBL) learning model influences the learning outcomes of seventh-grade students of Middle School 4 Palimanan, Cirebon Regency, in science subjects with a fairly strong influence category, where the calculated t value = 4.637 > t table = 1.672 with an influence of 25.8%, and the remaining 74.2% is influenced by other variables not examined in this study. In addition, the implementation of the ethnoscience-based Project Based Learning (PjBL) learning model has an influence on the scientific literacy of seventh-grade students of Middle School 4 Palimanan, Cirebon Regency, in science subjects with a strong influence category, where the calculated t value = 7.537 > t table = 1.672 with an influence of 48.6%, while the remaining 51.4% is influenced by other variables not examined in this study.

We recommend further research to develop detailed modules or teacher guides for ethnoscience-based PjBL models. Collaborate with science teachers to ensure ethnoscience integration is relevant and aligned with the curriculum. Ensure the selected projects are truly relevant to the students' culture and environment.

REFERENCES

Ardianti, S. D., & Raida, S. A. (2022). The effect of project based learning with ethnoscience approach on science conceptual understanding. *Journal of Innovation in Educational and Cultural Research*, *3*(2), 207-214. https://doi.org/10.46843/jiecr.v3i2.89

Bellová, R., Melicherčíková, D., & Tomčík, P. (2018). Possible reasons for low scientific literacy of Slovak students in some natural science subjects. *Research in Science & Technological Education*, *36*(2), 226-242. https://doi.org/10.1080/02635143.2017.1367656

Efendi, M. H., & Muliadi, A. (2023). Ethnoscience-based science learning in sasak ethnic culture: literature review. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 22-33. https://jppipa.unram.ac.id/index.php/jppipa/article/view/3769

Fasasi, R. A. (2017). Effects of ethnoscience instruction, school location, and parental educational status on learners' attitude towards science. *International Journal of Science Education*, *39*(5), 548-564. https://doi.org/10.1080/09500693.2017.1296599

Fortus, D., Lin, J., Neumann, K., & Sadler, T. D. (2022). The role of affect in science literacy for all. *International Journal of Science Education*, *44*(4), 535-555. https://doi.org/10.1080/09500693.2022.2036384

Hidayah, A., Rokhimawan, M. A., & Suherman, R. (2024). Implementation of ethnoscience-based PjBL on science literacy learning outcomes. *Journal of Innovation in Educational and Cultural Research*, *5*(3), 398-407. https://doi.org/10.46843/jiecr.v5i3.1278

Hikmawati, H., Suastra, I. W., & Pujani, N. M. (2021). Ethnoscience-based science learning model to develop critical thinking ability and local cultural concern for junior high school students in Lombok. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 60-66. https://doi.org/10.29303/jppipa.v7i1.530

Hussein, B. (2021). Addressing collaboration challenges in project-based learning: The student's perspective. *Education Sciences*, *11*(8), 434. https://doi.org/10.3390/educsci11080434

Kamariah, Muhlis, & Ramdani, A. (2024). Pengaruh Penggunaan Model Pembelajaran Project Based Learning (PJBL) Terhadap Literasi Sains Peserta Didik. *Jurnal Pelita: Jurnal Pembelajaran IPA Terpadu*, *4*(2), 160–171. https://doi.org/10.29303/jcar.v5i1.2925

Kennedy, T. J., & Sundberg, C. W. (2020). 21st century skills. In *Science education in theory and practice: An introductory guide to learning theory* (pp. 479-496). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-43620-9_32

Kong, S. C., Cheung, M. Y. W., & Tsang, O. (2024). Developing an artificial intelligence literacy framework: Evaluation of a literacy course for senior secondary students using a project-based learning approach. *Computers and Education: Artificial Intelligence*, *6*, 100214. https://doi.org/10.1016/j.caeai.2024.100214

Mardianti, I., Kasmantoni, K., & Walid, A. (2020). Pengembangan modul pembelajaran IPA berbasis etnosains materi pencemaran lingkungan untuk melatih literasi sains siswa kelas VII di SMP. *Bio-Edu*, *5*(2), 97-106. https://doi.org/10.32938/jbe.v5i2.545

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2023). Project-based learning and its effectiveness: evidence from Slovakia. *Interactive Learning Environments*, *31*(7), 4147-4155. https://doi.org/10.1080/10494820.2021.1954036

Mijaya, N. P. A. P., Sudiatmika, A. A. I. A. R., & Selamet, K. (2019). Profil literasi sains siswa SMP melalui model pembelajaran levels of inquiry. *Jurnal Pendidikan Dan Pembelajaran Sains Indonesia (JPPSI)*, *2*(2), 161-171. https://doi.org/10.23887/jppsi.v2i2.19385

Miranda, M., Saiz-Linares, Á., da Costa, A., & Castro, J. (2020). Active, experiential and reflective training in civil engineering: evaluation of a project-based learning proposal. *European Journal of Engineering Education*, *45*(6), 937-956. https://doi.org/10.1080/03043797.2020.1785400

Mukti, H., Suastra, I. W., & Aryana, I. B. P. (2022). Integrasi Etnosains dalam pembelajaran IPA. *JPGI (Jurnal Penelitian Guru Indonesia)*, *7*(4), 356-362. https://doi.org/10.29210/022525jpgi0005

Park, S. Y., Cha, S. B., Lim, K., & Jung, S. H. (2014). The relationship between university student learning outcomes and participation in social network services, social acceptance and attitude towards school life. *British Journal of Educational Technology*, *45*(1), 97-111. https://doi.org/10.1111/bjet.12013

Parmin, P., & Fibriana, F. (2019). Prospective teachers' scientific literacy through ethnoscience learning integrated with the indigenous knowledge of people in the frontier, outermost, and least developed regions. *Jurnal Penelitian Dan Pembelajaran IPA*, *5*(2), 142-154. http://dx.doi.org/10.30870/jppi.v5i2.6257

Pérez-Pérez, M., Serrano-Bedia, A. M., & García-Piqueres, G. (2020). An analysis of factors affecting students perceptions of learning outcomes with Moodle. *Journal of Further and Higher Education*, *44*(8), 1114-1129. https://doi.org/10.1080/0309877X.2019.1664730

Perifanou, M., & Economides, A. A. (2025). Collaborative uses of GenAI tools in project-based learning. *Education Sciences*, *15*(3), 354. https://doi.org/10.3390/educsci15030354

Putri, F. A., & Mufit, F. (2023). Analysis of Students' Scientific Literacy on Work and Energy as Well as Momentum and Impulse. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10583-10589. https://jppipa.unram.ac.id/index.php/jppipa/article/view/5990

Rahman, A. A., Santosa, T. A., Nurtamam, M. E., Widoyo, H., & Rahman, A. (2023). Meta-Analysis: The Effect of Ethnoscience-Based Project Based Learning Model on Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 611-620. https://jppipa.unram.ac.id/index.php/jppipa/article/view/4871

Rayis, W. P. A., Herayanti, L., Prayogi, S., & Kurnia, N. (2023). Integration of ethnoscience in science Learning: An ethnoscience study on the palm sugar production process. *Lensa: Jurnal Kependidikan Fisika*, *11*(2), 97-115. https://doi.org/10.33394/j-lkf.v11i2.14455

Rusmansyah, R., Leny, L., & Sofia, H. N. (2023). Improving students' scientific literacy and cognitive learning outcomes through ethnoscience-based PjBL model. *Journal of Innovation in Educational and Cultural Research*, *4*(1), 1-9. https://doi.org/10.46843/jiecr.v4i1.382

Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing local wisdom within character education through ethnopedagogy apporach: A case study on a preschool in Yogyakarta. *Heliyon*, *10*(10). https://doi.org/10.1016/j.heliyon.2024.e31370

Sari, F. P., Maryati, M., & Wilujeng, I. (2023). Ethnoscience studies analysis and their integration in science learning: Literature review. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1135-1142. https://jppipa.unram.ac.id/index.php/jppipa/article/view/2044

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life?. *Science Education*, *104*(5), 873-894. https://doi.org/10.1002/sce.21581

Sucilestari, R., Ramdani, A., Sukarso, A. A., Susilawati, S., & Rokhmat, J. (2023). Project-Based Learning Supports Students' Creative Thinking in Science Education. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 1038-1044. https://jppipa.unram.ac.id/index.php/jppipa/article/view/5054

Sukackė, V., Guerra, A. O. P. D. C., Ellinger, D., Carlos, V., Petronienė, S., Gaižiūnienė, L., ... & Brose, A. (2022). Towards active evidence-based learning in engineering education: A systematic literature review of PBL, PjBL, and CBL. *Sustainability*, *14*(21), 13955. https://doi.org/10.3390/su142113955

Valladares, L. (2021). Scientific literacy and social transformation: Critical perspectives about science participation and emancipation. *Science & Education*, *30*(3), 557-587. https://doi.org/10.1007/s11191-021-00205-2

Walker, D. I., Roberts, M. P., & Kristjánsson, K. (2015). Towards a new era of character education in theory and in practice. *Educational review*, *67*(1), 79-96. https://doi.org/10.1080/00131911.2013.827631

\Yacoubian, H. A. (2018). Scientific literacy for democratic decision-making. *International Journal of Science Education*, *40*(3), 308-327. https://doi.org/10.1080/09500693.2017.1420266

Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, *29*(1), 145-185. https://doi.org/10.1007/s11191-019-00100-x