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The Project Based Learning Integrated Ethnoscience: A Model of Learning to Enhance Scientific Literacy Among Pre-Service Elementary Teacher

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Abstract: This study aims to determine the effect of ethnoscience-based Project-Based Learning (PjBL) on students' science literacy, measure the level of improvement in students' science literacy, and analyze students' science literacy levels in terms of context, competence, and knowledge aspects. The research uses a mixed-method approach with a sequential explanatory design. The quantitative part of the study is conducted using a quasi-experiment, while the qualitative part employs field research. Data analysis techniques include the Mann-Whitney U test for quantitative data and triangulation techniques to validate data. The Miles and Huberman and Saldana model is used for qualitative data analysis.The study found that the use of ethnoscience-based PjBL significantly affects students' science literacy, with a significance value of 0.003 < 0.05. The increase in science literacy in the experimental class is categorized as high, at 0.71, while the control class shows a moderate category, at 0.60. In terms of science literacy levels, the experimental class reached a minimum of level 4, while the control class still had students at level 3. This means that students in the experimental class had better science literacy compared to the control class, particularly in terms of prospective elementary school teachers. Among the three aspects of science literacy, the competence aspect was the highest in both the experimental and control classes compared to the other aspects.

Keywords: Ethnoscience; Project Based Learning; Scientific Literacy

Introduction

Science literacy is considered highly important because it is the key to facing various 21st-century challenges and is a fundamental literacy skill essential for achieving 21st-century competencies (Fatimah, 2022). Science literacy is crucial for every individual, as it is closely related to one's understanding of the environment and other issues faced by modern society, which heavily relies on advancements in science and technology, including social issues (Asyhari & Hartati, 2015; Pujiati, 2019; Sholahuddin et al., 2021). One factor that needs attention in developing science literacy is engaging students in learning and creating an enjoyable learning environment, making students more prepared to learn and better at understanding science (Fatimah, 2022; Fatimah et al., 2021).

In reality, science literacy skills have yet to become a core component of the science curriculum in Indonesia (Kemdikbud, 2019). As a result, the average PISA scores of Indonesian students remain low and tend to decline. Some interesting findings indicate that Indonesia is positioned in the "low performance with high equity" quadrant.

Based on PISA results, the government has directed all educational institutions to collaborate in improving the quality of education in Indonesia, as PISA survey results are one of the benchmarks for a country's educational quality (Fenanlampir et al., 2019). One way institutions can contribute is by encouraging students to develop higher-order thinking skills (Kemdikbud, 2019).

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Cultivating these skills has become a key focus in current curriculum development. It is noted that through these thinking skills, students can better understand themselves, learn how to interact with others, evaluate themselves, make choices, and draw intelligent conclusions.

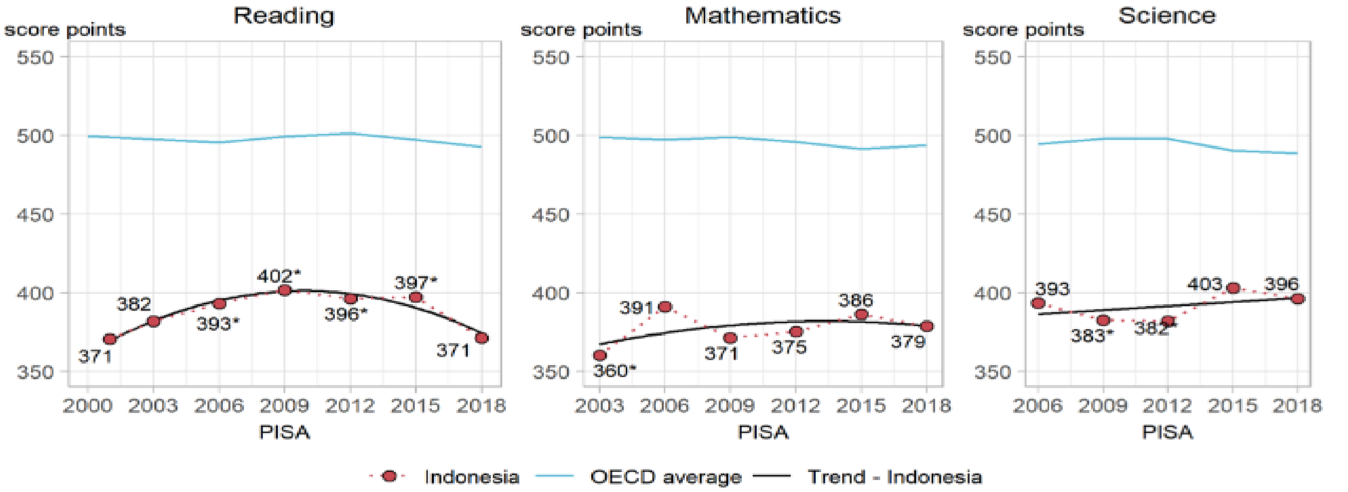


Figure 1. Trend score PISA(OECD, 2018)

One instructional model that can develop thinking skills is Project-Based Learning (PjBL). Suryandari et al. state that the PjBL model can be used in teaching to foster students' thinking skills (Suryandari et al., 2018). Chiang and Lee emphasize that problem-solving is a critical aspect of project-based learning (Chiang & Lee, 2016). To complete a project, students need to overcome various challenges, which helps them develop more effective and meaningful problem-solving skills. Findings by Karomantunnisa et al. also indicate that PjBL can enhance students' creative and critical thinking skills. Additionally, PjBL supports collaboration and problem-solving skills (Karomatunnisa et al., 2022). Williams explains that project-based learning offers students opportunities for active learning and the chance to acquire new soft skills, such as collaboration, communication, and negotiation (Williams, 2017).

Project-based learning will be more effective in enhancing students' skills by integrating local wisdom from the region.. Sudarmin states that through local wisdom, basic theories related to scientific reconstruction can be found, thereby enhancing conservation skills related to the maintenance, preservation, and wise use of natural resources (Sudarmin & Pujiastuti, 2015). This indigenous science is acquired through the observation of cultures within society. Through the reconstruction of indigenous science, applications of scientific concepts can be developed, thus deepening the understanding of scientific concepts (Khusniati, 2014). Figure 2 illustrates a framework for science teachers to integrate indigenous knowledge into science education (Zidny et al., 2020).

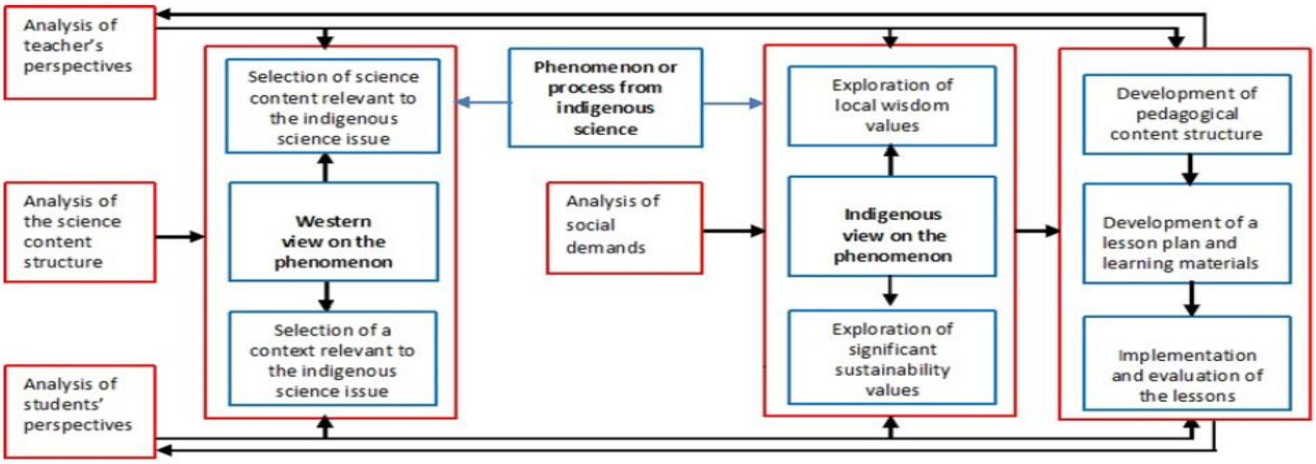


Figure 2. Framework for integrating indigenous knowledge into science education

Figure 2 shows that the selection of phenomena is the focus of the science education framework that integrates indigenous knowledge. This can be done by selecting indigenous/local wisdom contexts available in the region (Zidny et al., 2020). The phenomena developed should be challenging and even mysterious to spark students' curiosity (Grillenberger et al., 2016). Interesting topics also encourage students to explore the local wisdom behind scientific phenomena (Zidny et al., 2020).

Based on the background explanation above, the purpose of this study is to determine the effect of using an ethnoscience-based PjBL model in improving students' science literacy and to analyze their science literacy levels.

Method

The research is a mixed methods research with a sequential explanatory type (Creswell, 2014). Sequential exploratory research is research where data collection begins with quantitative data collection and then continues with qualitative data collection. Quantitative research is carried out using experimental method. Experimental methods are included in quantitative research. Fraenkel, and Wallen state that to experiment is to try, to look for, to confirm (Fraenkel & Norman, 2009). Patzer states that causal relationships are the heart of experiment (Patzer, 1996). Thus, cause and effect relationships are at the heart of experimental research. This study will implement the Project-Based Learning (PjBL) model integrated with ethnoscience to enhance the science literacy skills of prospective elementary school teachers. The science literacy indicators follow those stated by PISA, consisting of three aspects: context, competence, and knowledge. The questions used consist of twenty items. After the scores are collected, the science literacy skills of Pre-Service Elementary Teacher will be analyzed. The research subjects were Pre-Service Elementary Teacher in the Field Experience Practice course. Sampling was carried out using a simple random sampling technique. This research uses a Quasi Experimental Design in the form of a pretest-posttest nonequivalent control group design.

Nonequivalent pretest-posttest research design control group design (Sugiyono, 2011) can be illustrated in Table 1.

Table 1. Nonequivalent pretest-posttest research design control group design

Group	Pretest	Treatment	Postest
Experimental	O1	X	O2
Control	O3	-	O4

Information: O_1: Mean pretest score of the experimental group, O_2: Mean posttest score of the experimental group, O_3 : Mean pretest score of the control group, O_4: Mean posttest score of the control group, X: Treatment treatment is based on PjBL integrated ethnoscience.

The dotted line shows the means of the study between the experimental group and a control group that was not randomly selected (Cohen et al., 2007). The data collection technique in this research used test. This test was used to evaluate the science literacy level of preservice elementary teachers. Evaluation was carried out on both experimental and control classes. The test consists of two stages, namely pretest and posttest which will be given to the experimental group and control group.

Hypothesis testing using Mann-Whitney U test with the help of SPSS software. To measure the increase in the extent to which the target was achieved from the beginning before treatment (initial ability test) to the target learning outcomes after treatment (posttest) using the N-Gain formula. Calculate the normalized Gain score based on the formula according to Archambault (Archambault, 2008), namely:

$$N-Gain = \frac{Skor\ Postest - Skor\ Pretest}{Skor\ Maksimal\ - Skor\ Pretest} \times 100 \quad (1)$$

To measure the level of improvement in students' science literacy skills, the N-Gain is used, with the following categories: 0.70 < N-Gain ≤ 1.00 classified as high; 0.30 < N-Gain ≤ 0.70 classified as moderate; and N-Gain ≤ 0.30 classified as low. Qualitative research was carried out using observation, interviews and documentation. The validity of data in qualitative research is carried out using triangulation techniques. The data is then analyzed using the interactive analysis technique formulated by Miles, Huberman, & Saldana (Miles et al., 2014). This study utilizes the data analysis technique of Miles, Huberman, and Saldana, which consists of three stages: data condensation, data display, and conclusions. Data condensation involves collecting data first and then sorting it based on research needs. If there is data that is considered irrelevant then it is ignored. In data reduction, classification is also carried out based on variables. The data is divided into two main aspects, namely data about the learning process using project based learning integrated ethnoscience and analysis of enhancing Scientific Literacy Among Pre-Service Elementary Teacher. The next stage is to present the data in various forms, including descriptions, tables and pictures, so that readers can understand the meaning of the research data. The final step is verification/drawing conclusions, where the existing data is summarized based on the research objectives, and overall conclusions are drawn from the conclusions of each objective. Table 2 is an interpretation of the literacy ability levels of preservice elementary teachers (Nasor et al., 2023).

Table 2. Scientific literacy level criteria

Score Range	Scientific Literacy Level	Criteria
93-100	6	Very Good
73-92	5	Good
55-72	4	Enough
40-54	3	Deficient
14-39	2	Low
7-13	1.a	Very Low
1-6	1.b	Very Low

The following is an explanation of each level of scientific literacy:

Table 3. Description Scientific Literacy level

Scientific Literacy Level	Description
6	Students at this level provide explanations of scientific concepts from physical, life, and earth sciences to offer explanatory hypotheses or make predictions about new scientific phenomena
5	Students at this level can utilize abstract scientific concepts to explain complex phenomena, events, and processes that involvecausal relationships
4	Students at this level can utilize their advanced content knowledge to explain unfamiliar events and phenomena
3	Students at this level can utilize complex content knowledge to identify and explain phenomena in unfamiliar or complex situations
2	Students at this level can use every daycontent and procedural knowledge to scientifically explain, interpret data, and answer simple design questions
1.a	Students at this level can utilize primary procedural knowledge in everyday life to recognize and explain simple scientific phenomena
1.b	Students can utilize basic scientific knowledge to identify familiar aspects or simple phenomena, identify data patterns, understand basic terms, and follow explicit procedures

Result and Discussion

The use of an ethnoscience-integrated PjBL model to improve the science literacy skills of pre-service elementary school

Based on the results of hypothesis testing using the Mann-Whitney U test, a summary of the results is shown in Table 4. The hypotheses in this study are:

Hypothesis 1: There is an effect of the ethnoscience-based PjBL model on science literacy.
Hypothesis 2: There is no effect of the ethnoscience-based PjBL model on science literacy.
Table 4 shows that ethnoscience-integrated project-based learning has an effect on students' science literacy, with a significance value of 0.003 < 0.05. This result aligns with research conducted by Rusmansyah et al., which found that ethnoscience-based PjBL impacts science literacy. The research also indicates a significant difference in students' science literacy between the experimental and control classes (Rusmansyah et al., 2023).
After performing diagnostic tests and observing the process in the field through observations, N-Gain calculations were then conducted to obtain information about the difference in scores before and after the ethnoscience-based PjBL. The N-Gain test data is presented in Table 5.

Table 4. Summary of Mann-Whitney-U Results

	Scientific Literacy
Mann-Whitney U	235.000
Wilcoxon W	670.000
Z	-2.608
Asymp. Sig. (2-tailed)	.003

a. Grouping Variable: Class

Table 5. N-Gain Test Results for Scientific Literacy

Class	Test	Average	N-Gain	Category
Experiment	Pre-test	20.25	0.71	High
	Post-test	77.38		
Control	Pre-test	20.00	0.60	Moderate
	Post-test	68.55		

Table 5 shows the level of improvement in science literacy for the experimental and control classes. The results indicate that the improvement in science literacy for students using the ethnoscience-based PjBL model falls under the high category, with an N-Gain of 0.71. Meanwhile, the improvement in science literacy for students in the control class falls under the moderate category, with an N-Gain of 0.60. These results prove that learning with the ethnoscience-based PjBL model leads to a greater improvement in science literacy compared to the control class. This finding is consistent with the research conducted by Sholahuddin et al., which showed an improvement in science literacy through ethnoscience-based project learning (Sholahuddin et al., 2021).

Science Literacy Level of Pre-service Elementary School

This study used 20 essay questions designed based on the PISA (Programme for International Student Assessment) science literacy skill indicators, which include 1) Context, 2) Knowledge, and 3) Competence (OECD, 2018). The students' responses were then analyzed to assess their proficiency in science literacy skills. The results of the descriptive analysis of the science literacy skills of preservice elementary teachers are shown in Table 6.

Table 6. Descriptive Analysis of Science Literacy Skills (Experiment Class)

Aspect	Indicator	Higest Score	Lowest Score	Average Score
Context	Personal	88.00	68.00	83.00
	Local/Nation	85.00	65.00	75.00
	Global	80.00	60.00	70.00
Competencies	Explaining phenomena scientifically	90.00	75.00	85.00
	Evaluating and designing scientific inquiry	88.00	70.00	80.00
	Interpreting data and evidence scientifically	83.00	65.00	78.00
Knowledge	Content	85.00	65.00	75.00
	Procedural	88.00	63.00	80.50
	Epistemic	80.00	60.00	70.00

Table 6 shows that the science literacy scores in the experimental class, particularly in the Competencies aspect, were the highest compared to the other aspects. The indicator Explaining phenomena scientifically had the highest average score, which was 85.00. The high score in this aspect is due to the stage of analyzing essential questions, starting with contextual issues, such as analyzing scientific phenomena related to local wisdom in the region. On the other hand, the indicator Evaluating and designing scientific inquiry was also quite high, following Explaining phenomena scientifically. The activities of designing and evaluating inquiries were emphasized in the PjBL model. The stages of designing and evaluating projects are essential activities in project-based learning, so these skills can develop significantly with PjBL.

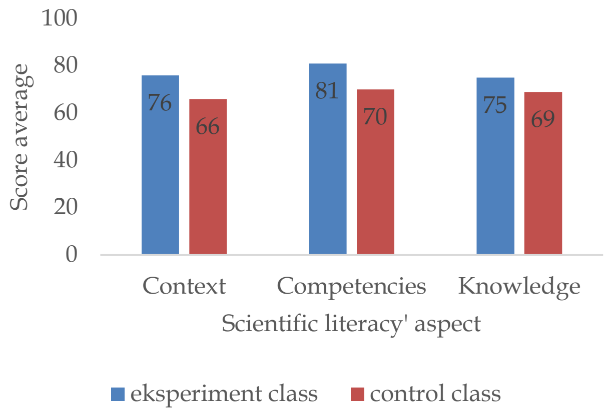
Table 7. Descriptive Analysis of Science Literacy Skills (Control Class)

Aspect	Indicator	Higest Score	Lowest Score	Average Score
Context	Personal	75.00	63.00	75.00
	Local/Nation	70.00	60.00	63.00
	Global	68.00	55.00	60.00
Competencies	Explaining phenomena scientifically	78.00	65.00	73.00
	Evaluating and designing scientific inquiry	75.00	60.00	70.00
	Interpreting data and evidence scientifically	75.00	50.00	68.00
Knowledge	Content	68.00	60.00	68.00
	Procedural	63.00	55.00	75.00
	Epistemic	60.00	50.00	65.00

Table 7 shows that the science literacy scores in the experimental class, particularly in the **Competencies** aspect, were the highest compared to the other aspects. The indicator **Explaining phenomena scientifically** had the highest average score, which was 73.00. In the control class, learning was conducted using conventional methods, specifically through experimental learning. Experimental learning plays an important role in developing skills such as analyzing phenomena and designing experiments. Therefore, these skills can be effectively developed through experimental learning.

Looking at the score range, the science literacy scores in both the experimental and control classes can be seen in Figure 3.

Figure 3 shows that the average science literacy score in the experimental class is higher compared to the control class. In terms of the competencies aspect, students' scores are better than in other aspects, both in the experimental and control classes. It is evident that science literacy in the experimental class, across all aspects, falls into the good category. In contrast, in the control class, all aspects of science literacy fall into the moderate category. The science literacy levels of the students can be seen in Figure 4.



Gambar 3. Comparison of the average science literacy scores of the experimental and control classes

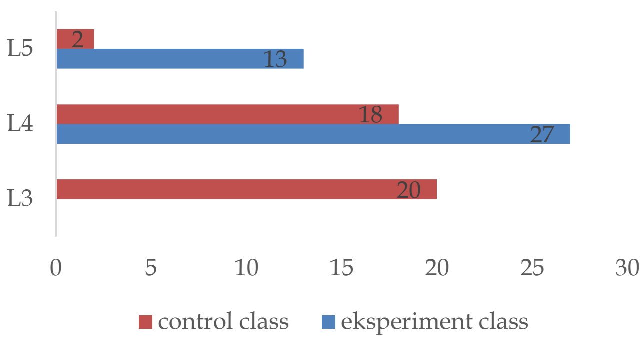


Figure 4. Science literacy level of experimental and control classes

Figure 4 explains that the science literacy levels in both the experimental and control classes show a difference. The science literacy level in the experimental class is higher compared to the level in the control class. It can be seen that in the experimental class, students' science literacy begins at level 4, where students are able to use advanced content knowledge to explain unfamiliar events and phenomena. In contrast, in the control class, some students are still at level 3, where they can use complex content knowledge to identify and explain phenomena in unfamiliar or complex situations. This level is considered to be in the low category. Meanwhile, 27 students in the experimental class have reached level 4, which is the most common level achieved by students in this class. In the control class, the most common level achieved by students is level 3, where students can use complex content knowledge to identify and explain phenomena in unfamiliar or complex situations. At level 5, only 2 students in the control class have reached this level, whereas in the experimental class, 13 students have achieved this level.

The science literacy skills possessed by students indicate that both in the experimental and control classes, students have a good level of ability, although in the control class, the ability is considered moderately good. However, the learning activities conducted have proven to have a significant impact on the development of students' science literacy. This result is relevant to research conducted by Fakhriyah et al., which found that the level of students' literacy abilities depends on the learning process that guides them in developing science literacy, including practical activities (Agustina et al., 2020; Fakhriyah et al., 2017; Lestari, 2021). Activities that focus more on hands-on learning have a greater impact compared to learning that is solely focused on memorization. Students who are only focused on memorizing content tend to have difficulty applying the knowledge they acquire in daily life, which results in low science literacy (Jufrida et al., 2021). Additionally, activities that focus on solving problems related to real-life phenomena and stimulate students' curiosity are believed to enhance their science literacy abilities (Budiarti & Airlanda, 2019; Mellyzar et al., 2022; Nasor et al., 2023).

The habituation of students in working on evaluation questions that are characterized by science literacy, which require high-level reasoning, is also one of the factors that contribute to the development of science literacy (Arrohman et al., 2022; Nasor et al., 2023). The lack of practice questions that focus on the development of science literacy has a significant impact on students' science literacy. PISA mentions that one of the factors influencing the high or low science literacy of students in Indonesia is the lack of practice questions based on science literacy. Therefore, habituating students to answer questions based on science literacy is an effective step in improving students' science literacy skills (Arrohman et al., 2022; Hasasiyah et al., 2020).

Based on the observation results, learning using the ethnoscience-based PjBL model better facilitates the development of students' science literacy compared to students who are only given practical activities. Through ethnoscience-based PjBL, students gain direct experience in acquiring knowledge and skills through complex projects and assignments, which encourages them to discover new concepts through activities such as designing, problem-solving, decision-making, and producing outcomes (Kulsum et al., 2020; Nugraha, 2022; Rusmansyah et al., 2023). The analysis of issues that are close to the students, such as local regional wisdom, helps students in enhancing their science literacy (Dewi, 2019; Hidayah et al., 2024).

Conclusion

This study found that the use of the ethnoscience-based PjBL model has an effect on students' science literacy, with a significance value of 0.003 < 0.05. The increase in science literacy in the experimental class showed a high category, with a score of 0.71, while the control class showed a moderate category, with a score of 0.60. In terms of science literacy levels, the experimental class was at least at level 4, while in the control class, some students were still at level 3. This indicates that students in the experimental class had better science literacy compared to the control class, particularly for prospective elementary school teachers. When considering the three aspects of science literacy, the competence aspect was the highest compared to the other aspects in both the experimental and control classes. This research can serve as a recommendation for researchers in the field of science education in efforts to improve science literacy skills. In addition to science literacy, 21st-century skills need to be developed for preservice elementary teachers as an effort to prepare outstanding future elementary school educators.

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Author Contributions
Conceptualization, Muhamad Chamdani; methodology, Muhamad Chamdani; analysis, Kartika Chrysti Suryandari; writing—original draft preparation, Muhamad Chamdani; writing—review and editing, Kartika Chrysti Suryandari and Murwani Dewi Wijayanti. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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