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Integrating Local Culture and Ethnoscience in Manggarai-Based STEM Education to Enhance Science Literacy and Scientific Attitudes in the 21st Century

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ABSTRACT

Science learning that has been applied so far, especially in science learning in elementary school students, has not integrated culture (ethnoscience). This makes the understanding of science very low. This study aims to analyze the influence of ethnoscience-based STEM approaches in the context of Manggarai culture on science literacy and scientific attitudes of elementary school students in Lamba Leda District. This goal was achieved by conducting an experimental study on the integration of ethnoscience-based STEM in the context of Manggarai culture to improve students' literacy and scientific attitudes and using control groups as a comparator. Statistical analysis used a multivariate variance analysis test. The results of the analysis of students' science literacy data showed a value of F = 7.513 ($P < 0.05$), then H0 was rejected. This means that there is a significant difference in students' science literacy in the experimental class and the control class. The results of the analysis of scientific attitude data showed that the value of F = 27,725 ($P < 0.05$), then H0 was rejected. The results of this effectiveness test show that the application of ethnoscience-based STEM approaches in the context of Manggarai culture can improve the literacy and scientific attitude of elementary school students.

I. Introduction

In the midst of an overwhelming influx of information, people are increasingly inclined to trust viral headlines over seeking scientific evidence. Personal opinions are frequently conflated with objective facts, while fake news spreads more rapidly than verification efforts. According to Jean Baudrillard, we are living in a world of simulation, where symbols, images, and information disseminated through media, advertising, and social platforms are mistaken for reality. In truth, these are merely representations of an objective fact that lies beyond the media's frame. The reality constructed within the media sphere is not actuality, but rather hyperreality, a fabricated version of truth designed to appear credible and be accepted as such. This phenomenon not only reshapes the way we interpret information but, more critically, influences how we define our sense of identity and truth. Increasingly, people strive to appear virtuous and socially acceptable in the digital realm rather than to live authentically in their everyday, offline lives (Antony & Tramboo, 2020).

The rapid advancement of technology, particularly Artificial Intelligence and deepfake technologies, has exacerbated this situation. Virtual realities, crafted through algorithms and digital manipulation, increasingly lead Millennials and Generation Z to engage more with illusions than with factual reality. Phenomena like "interaction greetings," now common in online communication, have become emblematic of a fabricated everyday existence. Yet beneath this facade lies a deeper friction: a reflection of the widespread lack of scientific literacy and scientific attitudes. In a digital landscape saturated with simulation and informational noise, scientific literacy emerges as a crucial compass for both learners and the broader public. Twenty-first-century science education emphasizes the importance of scientific literacy as a core competence, a fundamental skill that must be cultivated, particularly among students. This includes the ability to understand scientific knowledge in diverse contexts, think scientifically, and apply scientific reasoning critically (Afriana et al., 2016) (Vieira & Tenreiro-Vieira, 2016). Scientific literacy must go beyond simply grasping scientific facts and concepts. More

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importantly, it involves the ability to reflect, think critically, solve problems, adopt a healthy skepticism, and identify science-related issues grounded in data and technology (Dewi et al., 2019).

21st-century science education expects the achievement of science literacy skills and scientific attitudes. Science literacy emphasizes scientific knowledge in various contexts by thinking scientifically and implementing science critically (Vieira & Tenreiro-Vieira, 2016), so science literacy is an essential skill for learners. Science literacy is a 21st-century skill in science education. A person who has science literacy skills is able to understand, reflect, reason critically, solve problems, apply skepticism, and identify scientific issues based on scientific and technological understanding (Dewi et al., 2019).

Science literacy is the ability of students to solve problems and apply science in daily life (Supriyadi et al., 2023). Experts put forward several definitions of science literacy. According to Paul De Hurd, (DeBoer, 2000) science literacy is the skill to understand science and its application to the needs of society. (McLachlan et al., 2012) Defines science literacy as understanding, using, and reflecting on written texts to achieve one's goals in developing knowledge and potential to participate in society. Science literacy is the ability to understand and use written language forms needed by society in building the meaning of various science texts (OECD, 2000). Defines science literacy as the understanding of written texts to reflect, develop knowledge, and the potential to participate in society.

Science literacy is a 21st-century skill (DeBoer, 2000) that students need to face the challenges of the 21st century. The leading indicators of science literacy are: scientific contexts, scientific knowledge, scientific competencies, and scientific attitudes (Davies & Priestley, 2017). Scientific contexts refer to the understanding of scientific concepts and their application to daily life situations. Scientific knowledge refers to the experience of the content of science and the process of science. Scientific competencies refer to the scientific processes involved when answering a question or solving a problem, such as identifying and interpreting evidence and explaining conclusions. Scientific attitudes refer to attitudes towards science related to scientific interests, sensitivity to the environment, and attitudes of responsibility (Davies & Priestley, 2017). Science literacy is closely related to scientific attitudes toward science.

Scientific attitude is a condition of student readiness for a specific type of activity. Science attitudes show interest or feelings towards learning science (Ragini Singh & Singh, 2016). The scientific attitude of science that is developed refers to several attitudes, namely, 1) the attitude to test scientific evidence, identify the relationship of cause and effect, and accept criticism and input to improve the results of findings. 2) the curiosity to understand the new knowledge of science through the scientific process of the "why", "what", and "how" of the observed phenomena. 3) An open-minded attitude, being willing to revise the results of inputs and conclusions, the desire for new things and new ideas, and acknowledging the concept of conclusions scientifically rather than on personal opinions. 4) Accept facts and conclusions based on scientific findings, objectivity and scepticism (Sakariyau et al., 2016).

Improving scientific attitudes is an essential aspect that students must have in facing global challenges with evidence-based thinking and logic. Scientific attitudes show interest or feelings towards learning science (Ragini Singh & Dr. Rashmi Singh, 2016). The American Association for the Advancement of Science (AAAS) identifies the dimensions of scientific attitudes, namely: honesty, curiosity, openness, and skepticism (Widyasari & Haryanto, 2022). Being a scientist means being able to explain these behaviors and attitudes in approaching and solving problems, which are based on scientific inquiry (Gupta, 2015). Scientific attitudes are attitudes possessed by scientists that can be developed in students through the process of science (Hasan, 2017). The involvement of the science process is an effort to help students find scientific evidence validly, critically, openly, honestly, cooperatively, and with a great curiosity.

However, in reality, the quality of science education in Indonesia is still relatively low compared to other developing countries. The weakness of education in Indonesia is the low achievement of science literacy levels in the Programme for International Student Assessment (PISA). In 2000, Indonesia was ranked 38th out of 41 participating countries. In 2003, Indonesia ranked 38th out of 40 participating countries. In 2006, the number of participating countries increased; Indonesia was ranked 50th out of 57 countries, while Indonesia ranked 60th out of 65 countries in 2009. According to PISA 2012 data, Indonesia was ranked 64th out of 65 participating countries. As a result of the 2015 PISA data, Indonesia was ranked 63rd out of 70 countries in the world (Afriana et al., 2016). PISA 2022 for science literacy scores decreased by 13 points from PISA 2018 (OECD, 2023). Based on the results of the PISA assessment, the ability of Indonesian students in the field of science literacy compared to other developing countries is still low.

One approach that can improve science literacy and scientific attitudes is the STEM (Science, Technology, Engineering, and Mathematics) approach. STEM leads to knowledge that is sourced from local culture (ethnoscience). STEM-based science education can help students access and apply scientific knowledge in the face of Industry 4.0 (Thao et al., 2024), as well as improve students' science literacy and scientific attitudes (Hanim & Wulandari, n.d.). However, in its application, STEM approaches are still often considered less contextual because they do not take into account local wisdom and local culture. To overcome these limitations, the integration of ethnoscience-based STEM in the context of Manggarai culture is an innovative solution to improve science literacy and the scientific attitudes of students in elementary schools.

Ethnoscience-based STEM can explain cultural values as scientific practices and sources of knowledge (Verawati et al., 2023). Education is not only in the form of knowledge transfer, but also a vehicle for internalizing knowledge sourced from community culture (Murti et al., 2024). Ethnoscience-based STEM can improve creative thinking and problem-solving skills in students (Babalola & Keku, 2024). Ethnoscience-based STEM approaches in the context of Manggarai culture can be developed in teaching modules (Jihannita et al., 2024) that can be applied in learning. The implementation of ethnoscience-based STEM in learning can increase positive student responses (Sudarmin et al., 2023).

Integrating ethnoscience-based STEM approaches in IPAS Elementary as a reference to several existing literature reviews. The integrated ethnoscience is the revitalization of Manggarai local wisdom in the type of "*mbaru niang*" as a cultural heritage that contains scientific concepts, especially on the idea of IPAS and the environment. "That is new". Manggarai Regency is an area with a high risk of earthquakes and tornadoes, so the construction of the house is cone-shaped, namely low impact: more durable skeleton and health & amenity: through the choice of safe and eco-materials (Murti et al., 2024). This concept is used in IPAS to describe the relationship between nature and human life. This concept is an ethnoscience learning approach, namely, combining science and cultural learning.

Ethnoscience has the characteristics of presenting cultural topics and being related to science, developing understanding and deepening concepts, and exploration using scientific approaches (Ariani & Hariyadi, 2024). Ethnoscience-based science learning can improve students' critical thinking skills (Khery, 2025). The integration of ethnoscience into science teaching has an impact on improving students' scientific attitudes and student performance (Idul & Fajardo, 2023). Ethnoscience is often integrated into STEM approaches as a student-centered approach to learning. STEM, as an acronym for (science, technology, engineering, mathematics), is an interdisciplinary approach (Ilma et al., 2023) that studies various concepts and is connected to the real world. The application of science approaches has an impact on increasing interest, skills, and high-level thinking (Idris et al., 2023).

Thus, research on the integration of ethnoscience-based STEM in the context of Manggarai culture in social studies learning is significant to be developed. This study is expected to provide insight into how this approach can be applied effectively in education and its impact on students' scientific attitudes and science literacy. In addition, the results of this research can also be a reference for educators in designing learning strategies that are more , innovative, contextual, and oriented towards the preservation of local culture.

II. Method

The population of this study consists of all elementary school (SD) students in the Lamba Leda District, comprising a total of 39 schools. For the purposes of this research, a sample of 5 elementary schools was selected using a random sampling technique. The sampling process involved selecting five schools to serve as research samples: three classes from three different schools were assigned as experimental groups, which received ethnoscience-based STEM instruction incorporating elements of Manggarai culture in social studies lessons. Meanwhile, two classes from two other schools served as control groups, receiving conventional instruction. An equivalence test was conducted using a t-test at a 5% significance level.

The data collection methods used in this study are 1) instrument validation, 2) observation, 3) test, 4) questionnaire, and 5) documentation. The research procedure is carried out in three stages, namely: the initial stage, the experimental stage, the data collection stage, and the final stage. The research procedure is carried out in Table 1.

Table 1. Research Procedure

Group 1 (Experiment)	X1 (Ethnoscience-Based STEM Approach in the Context of Manggarai Culture)	O2 (Science Literacy and Scientific Attitudes)
Group 2 (Control)	X2 (Conventional Learning)	O2 (Science Literacy and Scientific Attitudes)

In the beginning, the research developed a grid of instruments to measure science literacy, namely the four dimensions of science literacy: the dimension of scientific contexts, the dimension of scientific knowledge, the dimension of scientific attitudes, and the dimension of scientific competencies. In addition, developing a grid of scientific attitude instruments from Wynne Harlen (Kane et al., 2016), namely, 1) curiosity, 2) respect for data, 3) hesitation, 4) critical reflection, 5) perseverance, 6) creativity and discovery, 7) open thinking, 8) sensitivity to the environment, 9) cooperation.

Descriptive analysis is in the form of data presentation with frequency and histogram distributions, means, medians, and standard deviations. Descriptive statistical analysis is used to describe students' scientific attitudes and science literacy. Qualifications are described on the ideal mean score (Mi) and the standard deviation or ideal standard deviation (SDi). After that, it is followed by prerequisite testing of data analysis, which tests data normality, data homogeneity, regression linearity, and data linearity. At this stage, the validation of science literacy and student learning retention instruments was carried out, which was analyzed using the RASCH model. The research hypothesis was analyzed using the following steps: 1) compiling the MANOVA table by calculating JP treatment, 2) calculating residual JP, and 3) calculating total JP (corrected). Once compiled in the MANOVA table, the following calculation Λ* with the formula:

$$\Lambda^* = \frac{|W|}{|B+W|}$$

Then, it was carried out by testing the hypothesis with the formula:

$$F = \left(\frac{\Sigma n_i - p - 1}{p}\right)\left(\frac{1 - \Lambda^*}{\Lambda^*}\right)$$

Testing hypotheses 1 and 2 was followed by an effectiveness test with an effect size test, namely: Es = t, with the effectiveness categories presented in Table 2.

Table 2. Category Effect Size

No.	Category	Information
1.	Es ≤ 0,2	Low
2.	Es ≤ 0,8	Enough
3.	Es > 0,8	Tall

III. Results and Discussion

Figure 1 presents the research results on the average score of each dimension of science literacy, namely scientific contexts, scientific knowledge, and scientific competencies.

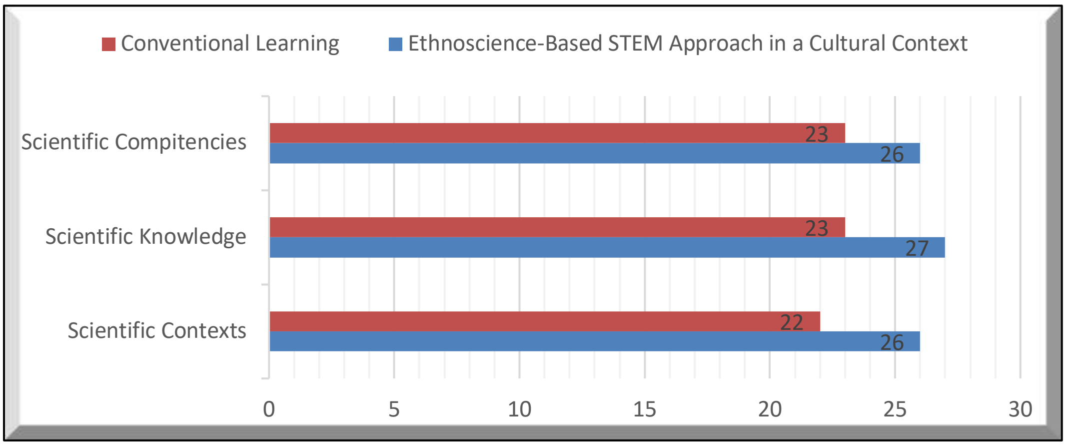

Fig. 1. Average Score of Dimensions of Scientific Contexts, Scientific Knowledge, and Scientific Competencies

The dimension of scientific attitude was measured using student performance observation sheets. Figure 2 presents a recapitulation of the average score of the scientific attitude dimension.

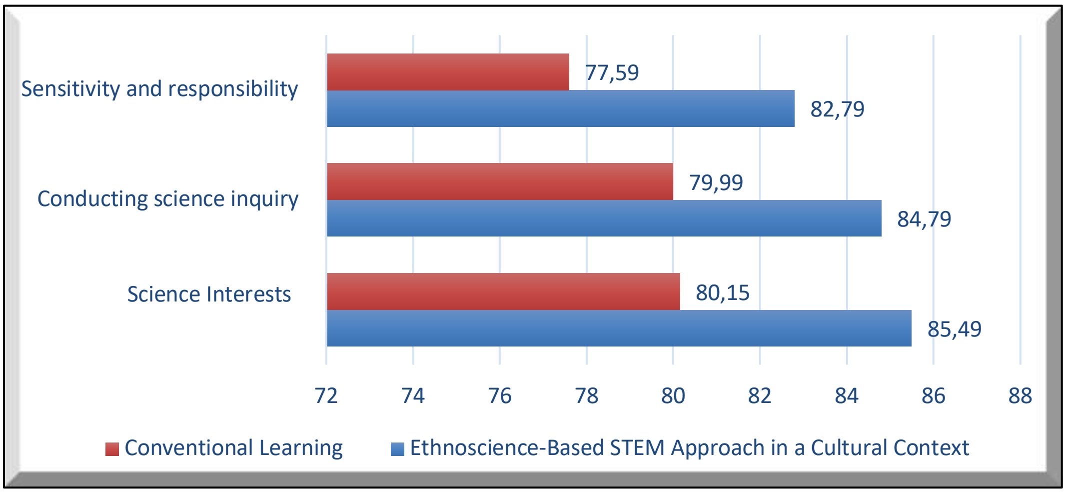

Fig. 2. Average Score Dimension of scientific attitude

Figure 3 presents the differences in the curve graph for the scientific attitude in the experimental class and the control class. The curve graph (a) shows that the statement given is so good that it can validly collect information. Statements given to students produce optimal information when given to individuals with moderate abilities. The curve graph (b) shows that the statement given is not good. Statements given to students result in suboptimal information when given to individuals with moderate ability.

Figure 4 presents the average score of the scientific attitude dimension of students who participated in science learning with ethnoscience-based STEM learning in the context of Manggarai culture and conventional learning.

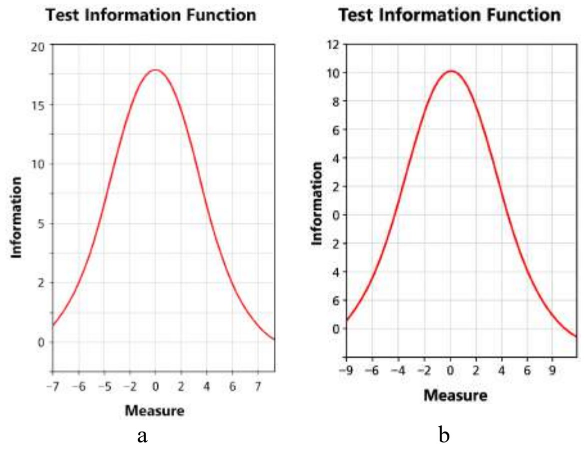

Fig. 3. Experimental class curve graph and (b) Control class curve graph

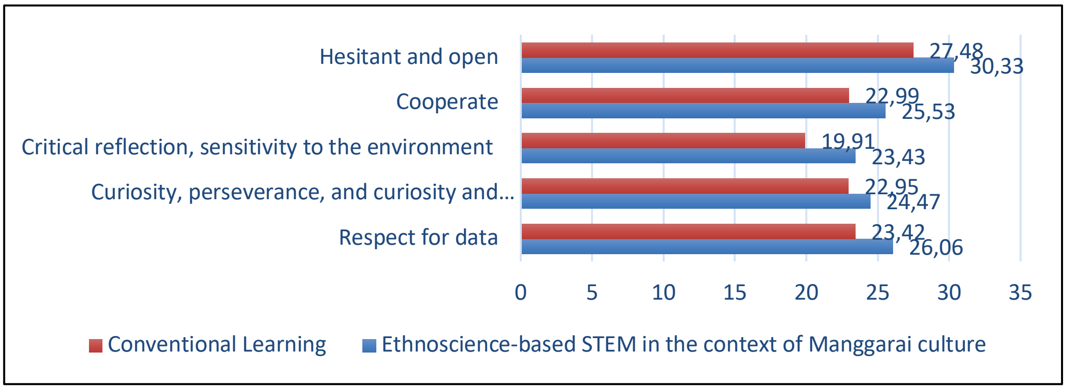

Fig. 4. Average Score of the Dimensions of Students' Scientific Attitude

Data analysis using Multivariate Analysis of Variance (MANOVA) with the SPSS 16.0 application. The results of data analysis showed that F-Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root were 13,786 (P < 0.05), so H0 was rejected. This means that there is a significant difference in science literacy and scientific attitudes between students who participate in science learning with ethnoscience-based STEM learning in the context of Manggarai culture and students who participate in science learning with conventional learning. The results of the analysis are presented in Table 5.

Table 3. Manova Results Recapitulation for Hypothesis Testing 2 and Hypothesis Testing 3.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Science Literacy	234.230[a]	1	234.230	**7.513**	.004
	Scientific Attitude	4061.700[b]	1	4061.700	**27.725**	.000
Intercept	Science Literacy	345968.150	1	345968.150	1.110E4	.000
	Scientific Attitude	2524195.643	1	2524195.643	1.723E4	.000
Learning	Science Literacy	234.230	1	234.230	7.513	.004
	Scientific Attitude	4061.700	1	4061.700	27.725	.000
Error	Science Literacy	5393.199	172	31.175		
	Scientific Attitude	25344.335	172	146.499		
Total	Science Literacy	351504.000	174			
	Scientific Attitude	2552527.000	174			

Tests of Between-Subjects Effects			
Corrected Total	Science Literacy	5627.429	173
	Scientific Attitude	29406.034	173

The results of the test of between-subjects effects on the difference in science literacy between students who participated in science learning with an ethnoscience-based STEM approach in the context of Manggarai culture and students who participated in science teaching with conventional learning, showed a value of F = 7.513 (P < 0.05) so H0 was rejected. This means that there is a significant difference in science literacy between students in the experimental class and the control class. The results of the pairwise comparisons test showed that the average difference in students' science literacy between the experimental group and the control class was 3.768 (P < 0.05), so the science literacy of students who participated in IPAS learning with an ethnoscience-based STEM approach in the context of Manggarai culture was significantly higher than the science literacy of students who participated in IPAS learning with conventional learning.

The results of the test of between-subjects effects on the difference in scientific attitudes between the students of the experimental class and the control class showed a value of F = 27.725 (P < 0.05), then H0 was rejected. This means that there is a significant difference in scientific attitudes between students who take part in learning IPAS with an ethnoscience-based STEM approach in the context of Manggarai culture and students who take part in learning IPAS with conventional learning. The results of the pairwise comparisons test showed that the average difference in students' science literacy between the experimental group and the control class was 9.635 (P < 0.05), so the scientific attitude of students who participated in IPAS learning with ethnoscience-based STEM learning in the context of Manggarai culture was significantly higher than the scientific attitude of students who participated in IPAS learning with conventional learning. The results of the effectiveness test showed that the value of Es = 0.31>0.8 was categorized as high.

The findings of this study are in line with the results of research by Kane et al. (2016), which concluded that there is an increase in high-level skills and science literacy from the application of ethnoscience-based STEM learning. The characteristics of ethnoscience-based STEM learning place more emphasis on self-discovery of concepts and problem-solving through cultural integration in science learning. The findings of this study are also in line with the results of research by Izzah et al. (2023), namely that there is an increase in students' critical thinking skills and scientific attitudes after integrating ethnoscience-based STEM approaches. Thus, the ethnoscience-based STEM approach in the context of Manggarai culture is very effective in improving science literacy and scientific attitudes in science learning in elementary schools.

IV. Conclusion

Based on the results of hypothesis testing as described, it can be concluded that science learning with STEM based on ethnoscience in the context of Manggarai culture can improve science literacy and scientific attitudes of elementary school students. In more detail, it can be concluded, namely; 1) there is a significant difference in science literacy between students who participate in science learning with an ethnoscience-based STEM approach in the context of Manggarai culture and students who participate in science learning with conventional learning; 2) there is a significant difference in scientific attitudes between students who participate in science learning with an ethnoscience-based STEM approach and students who participate in science learning with conventional learning; 3) there is a significant difference in science literacy and scientific attitudes simultaneously between students who participate in science learning with ethnoscience-based STEM approaches and students who participate in science learning with conventional learning; 4) The results of the effectiveness test show that the application of ethnoscience-based STEM approaches in the context of Manggarai culture can improve students' literacy and scientific attitudes.

References

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 202. https://doi.org/10.21831/jipi.v2i2.8561

Agus Supriyadi, Desy Desy, Yayat Suharyat, Tomi Apra Santosa, & Aulia Sofianora. (2023). The Effectiveness of STEM-Integrated Blended Learning on Indonesia Student Scientific Literacy: A Meta-analysis. *International Journal of Education and Literature*, *2*(1), 41–48. https://doi.org/10.55606/ijel.v2i1.53

Ariani, T., & Hariyadi, B. (2024). Integration of Ethnoscience Approach in Physics Learning Based on Laboratory Practice: A Systematic Literature Review. *Jurnal Penelitian Pembelajaran Fisika*, *15*(3), 252–262. https://doi.org/10.26877/jp2f.v15i3.18765

Babalola, E. O., & Keku, E. (2024). Ethno-STEM Integrated Project-Based Learning to Improve Students' Creative Thinking Skills. *International Journal of Ethnoscience and Technology in Education*, *1*(2), 116. https://doi.org/10.33394/ijete.v1i2.11308

Davies, R., & Priestley, C. (2017). Science Literacy in Developing Countries: Landscape Survey. *Network for Information and Digital Access*, 1–48. http://www.nida-net.org/documents/8/SL_Researcht_Report_Final.pdf

DeBoer, G. E. (2000a). Scientific literacy: Another look. *Journal of Research in Science Teaching*, *37*(6), 582–

601. https://web.nmsu.edu/~susanbro/eced440/docs/scientific_literacy_another_look.pdf

DeBoer, G. E. (2000b). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, *37*(6), 582–601. https://doi.org/10.1002/1098-2736(200008)37:6<582::AID-TEA5>3.0.CO;2-L

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Dr. Ragini Singh, & Dr. Rashmi Singh. (2016). A Correlation Study of Scientific Attitude and Scientific Interest of class IX Students. *International Journal of Indian Psychology*, *3*(3). https://doi.org/10.25215/0303.063

Gupta, S. (2015). *Influence of Students ' Gender and Stream of Study on*. *3*.

Hanim, M., & Wulandari, F. (n.d.). *Ethno-STEM Integrated Inquiry Learning Model towards Students' Scientific Literacy Ability [Model Pembelajaran Inkuiri Terintegrasi Etno-STEM Terhadap Kemampuan Literasi Sains Siswa]*. 1–9.

Hasan, H. Ş. (2017). The mediating role of scientific attitudes in the relationship between teacher candidates scientific epistemological beliefs and approaches to scientific research. *Educational Research and Reviews*, *12*(11), 604–610. https://doi.org/10.5897/err2017.3248

Husnul Mukti, I Wayan Suastra, & Ida Bagus Putu Aryana. (2022). Integrasi Etnosains dalam pembelajaran IPA. *JPGI (Jurnal Penelitian Guru Indonesia)*, *7*(1), 365–362.

Idris, R., Govindasamy, P., Nachiappan, S., & Bacotang, J. (2023). Revolutionizing STEM Education: Unleashing the Potential of STEM Interest Careers in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, *13*(7), 1741–1752. https://doi.org/10.6007/ijarbss/v13-i7/17608

Idul, J. J. A., & Fajardo, M. T. M. (2023). Ethnoscience-based physical science learning and its effects on students' critical thinking skills: A meta-analysis study. *Journal of Mathematics and Science Teacher*, *3*(2), em048. https://doi.org/10.29333/mathsciteacher/13700

Ilma, A. Z., Wilujeng, I., Widowati, A., Nurtanto, M., & Kholifah, N. (2023). A Systematic Literature Review of STEM Education in Indonesia (2016-2021): Contribution to Improving Skills in 21st Century Learning. *Pegem Egitim ve Ogretim Dergisi*, *13*(2), 134–146. https://doi.org/10.47750/pegegog.13.02.17

Izzah, S. N., Sudarmin, Wiyanto, & Wardani, S. (2023). Analysis of Science Concept Mastery, Creative Thinking Skills, and Environmental Attitudes After Ethno-STEM Learning Implementation. *International Journal of Instruction*, *16*(3), 777–796. https://doi.org/10.29333/iji.2023.16342a

Jihannita, J., Fadly, W., Ekapti, R. F., Luthfiana, D., & Widowati, A. (2024). The Development of Science Module Integrated with Ethnoscience of Singo Barong Mask to Improve Scientific Literacy and Cultural Preservation Attitudes. Journal of Innovation in Educational and Cultural Research, 5(2), 356–363. https://doi.org/10.46843/jiecr.v5i2.790

Kane, S. N., Mishra, A., & Dutta, A. K. (2016). Elvin Yusliana Ekawati, "A model of scientific attitudes assessment by observation in physics learning based scientific approach: case study of dynamic fluid topic in high school", Journal of Physics: Conference Series, Series 795 (2017) 012056, doi:10.1. *Journal of Physics: Conference Series*, *755*(1). https://doi.org/10.1088/1742-6596/755/1/011001

Khery, Y. (2025). *Effectiveness of ethnoscience-oriented projects to improve students' performance*.

McLachlan, C., Nicholson, T., Fielding-Barnsley, R., Merce, L., & Ohi, S. (2012). Literacy in early childhood and primary education: Issues, challenges and solutions. *Literacy in Early Childhood and Primary Education: Issues, Challenges and Solutions*, *15*, 1–332. https://doi.org/10.1017/CBO9781139519397

Murti, M., Zulkarnain, L., Arifin, L. S., Damayanti, R., Arsitektur, J., Teknik, F., Petra, U. K., No, J. S., Wonocolo, K., Surabaya, K., & Timur, J. (2024). *Studi Elemen Struktur Rumah Tradisional Mbaru Niang Pendahuluan Rumah adat merupakan warisan budaya di Desa Wae Rebo , Kabupaten dengan lantai dasar berbentuk lingkaran . Niang di Desa Wae Rebo , dengan total dengan mempertimbangkan aspek konstruksi rumah*. *10*(3), 275–285.

OECD. (2000). The PISA 2000 Assessment of Reading , Mathematical and Scientific Literacy. *Oecd*, 108.

OECD. (2023). PISA 2022 Results (Volume II): Learning During – and From – Disruption. In *OECD Publishing: Vol. II*. https://www.oecd-ilibrary.org/education/pisa-2022-results-volume-ii_a97db61c-en

Sakariyau, A., Taiwo, M. O., & Ajagbe, O. W. (2016). An investigation on secondary school students' attitude towards science in Ogun state , Nigeria. *Journal of Education and Practice*, *7*(28), 125–128. https://files.eric.ed.gov/fulltext/EJ1118531.pdf

Sudarmin, S., Savitri, E. N., Pujiastuti, R. S. E., & ... (2024). Reconstruction of Ethno-STEM Integrated Project Learning Models for Explanation of Scientific Knowledge Regarding Aroma Compounds of Indonesian and World …. ... *IPA Indonesia*, *13*(2), 195–208. https://doi.org/10.15294/jpii.v13i2.4556

Thao, N. P., Huong, L. T. T., Dinh, N. V., Hang, N. T. T., Quyen, C. V., Cuong, L. M., & Thao, T. T. P. (2024). Current Situation of Primary School Teachers' Integrated Stem Teaching Competence: an Exploratory Study in the Northern Mountainous Provinces of Vietnam. *Jurnal Pendidikan IPA Indonesia*, *13*(1), 64–75. https://doi.org/10.15294/jpii.v13i1.49636

Verawati, N. N. S. P., Hikmawati, H., & Prayogi, S. (2023). Tren Studi Etnosains dalam Pendidikan STEM: Analisis Bibliometrik pada Abstrak Manuskrip Riset. *Jurnal Ilmiah Profesi Pendidikan*, *8*(2), 1050–1057. https://doi.org/10.29303/jipp.v8i2.1415

Vieira, R. M., & Tenreiro-Vieira, C. (2016). Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. *International Journal* *of Science and Mathematics Education*, *14*(4), 659–680. https://doi.org/10.1007/s10763-014-9605-2

Westen, M., Svendsen, H., Larsen, D. M., & Svabo, C. (2015). *Expanding the STEM integration model, introducing the learning environment*. *12*(4), 1–19.

Widyasari, A., & Haryanto, H. (2022). Analysis of students' initial scientific literacy in elementary school teacher education students. *Jurnal Inovasi Pendidikan IPA*, *8*(1), 57–66. https://doi.org/10.21831/jipi.v8i1.41667

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