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META ANALYSIS: THE EFFECTIVENESS OF USING ETHNOSCIENCE-BASED SCIENCE MODULES IN IMPROVING STUDENTS' SCIENTIFIC LITERACY

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Abstract

This study aims to analyze the effectiveness of science modules based on ethnoscience in improving students' scientific literacy through a meta-analysis approach. Scientific literacy is a key 21st-century competency that encompasses conceptual understanding, critical thinking skills, and the ability to relate science to real-life contexts. However, various studies have shown that the level of scientific literacy among Indonesian students remains low, indicating the need for more contextual and meaningful learning approaches. Ethnoscience, as an integration of science and local culture, is seen as a promising approach to bridge the gap between science content and students' social realities. This study analyzed eight articles published between 2016 and 2025, selected based on their focus on the effectiveness of ethnoscience-based science modules in enhancing students' scientific literacy in Indonesia. Pretest and posttest data from each study were analyzed using descriptive statistics and effect size calculation through Cohen's d. The results showed that the average scientific literacy score increased from 44.65% (pretest) to 81.79% (posttest), with an average gain of 37.14%. The Cohen's d value of 2.865 indicates a very large effect size. These findings demonstrate that ethnoscience-based modules consistently improve students' scientific literacy and help reduce disparities in academic achievement. The study recommends the development of culturally relevant science modules and teacher training programs to ensure effective implementation in diverse educational contexts.

Introduction

The development of science and technology in the 21st century requires students to have strong scientific literacy skills as part of their basic competencies in facing global challenges. Scientific literacy is not only related to mastery of science concepts but also includes critical thinking, problem-solving, and scientifically informed decision-making skills. However, several studies show that the level of scientific literacy of Indonesian students is still relatively low, even below the average of OECD countries based on PISA results. Muizz et al. (2023) revealed that elementary school students' scientific literacy is still limited to basic knowledge and has not yet addressed the dimensions of context, process, and scientific attitudes. This finding is in line with the results of research by Dian (2022) , which states that many students still have difficulty understanding the concept of motion in science because the learning approach used does not connect science to students' local experiences and culture. Thus, a learning approach that can bridge this gap is needed.

Science learning in schools is often theoretical and tends to emphasize memorization of concepts without fostering in-depth understanding and connections to everyday reality. As a result, students experience difficulty applying science concepts to real-life contexts. In this regard, a culture-based approach such as ethnoscience offers an alternative approach to learning. Dian (2022) demonstrated that integrating local cultural elements into science learning modules can improve students' understanding of the material because they can relate the material to their environment. Meanwhile, research by Pardianiati et al. (2025) demonstrated that ethnoscience-based science modules are not only valid in terms of content and media but also have a positive effect on strengthening students' scientific literacy. Therefore, the development and implementation of modules based on local values are crucial for improving the quality of science learning.

The concept of ethnoscience reflects the integration of scientific knowledge with local cultural practices and values that have been passed down through generations. In an educational context, ethnoscience provides an opportunity to develop learning that is contextual, meaningful, and relevant to students' lives. Muizz et al. (2023) explain that ethnoscience can serve as a basis for developing science teaching materials that are more suited to the characteristics of students and their surrounding environment. Ethnoscience-based modules encourage students to not only understand scientific concepts theoretically but also to explore traditional knowledge and analyze it scientifically. Furthermore, this approach supports the development of scientific attitudes such as curiosity, openness to differences, and awareness of the importance of the local environment.

Several ethnoscience-based science learning modules have been developed and tested at various levels of education, including elementary, middle, and high school. These modules generally employ a scientific approach with a learning structure

that integrates observation, simple experiments, discussion, and reflection within a local cultural context. Pardianiati et al. (2025) developed a science e-module on food additives, highlighting traditional community practices in preserving food as contextual learning material. Validation results showed that the module was not only feasible to use but also effective in developing students' scientific thinking and scientific literacy skills. Similarly, Muizz et al. (2023) conducted a literature review and found that various ethnoscience-based modules demonstrated positive results in improving scientific literacy, particularly in scientific reasoning and the ability to relate knowledge to everyday life. This fact reinforces the importance of systematic documentation through meta-analytical studies to evaluate the effectiveness of the various modules developed.

Meta-analysis is an important scientific method for synthesizing results from multiple independent studies and systematically measuring the strength of effects. In the context of ethnoscience, meta-analysis can provide an overview of the effectiveness of this approach in improving students' scientific literacy. The meta-analysis approach plays a strategic role in providing a more comprehensive evaluation of ethnoscience-based modules. This is in line with research by Muizz et al. (2023), which revealed that meta-analysis provides empirical evidence regarding trends in module effectiveness across various levels and science fields, and highlights factors that can strengthen modules, such as cultural relevance, learning design, and evaluation strategies.

This study focuses on analyzing ethnoscience-based science modules published between 2016 and 2025 and implemented at elementary and secondary levels of education, namely elementary, middle, and high schools. The main objective of this analysis is to evaluate the extent to which these modules have an impact on improving students' scientific literacy. By reviewing findings from eight relevant articles, this study attempts to identify similarities in design patterns, pedagogical approaches, and the integration of local cultural values applied in the modules. This study is important because it can provide data-based information regarding the characteristics of modules that are most successful in helping students understand scientific concepts contextually and meaningfully.

In addition to evaluating the effectiveness of modules based on student learning outcomes, this study also sought to explore the distinctive characteristics of module designs that consistently demonstrate optimal results. Factors such as the structure of material presentation, the relationship between science and local culture, experimental activities, and evaluation strategies were analyzed to identify the key elements driving module success. By understanding these elements, this study can produce clear and measurable indicators of the effectiveness of an ethnoscience-based module, thus serving as a reference for educators, curriculum developers, and

teacher training institutions in designing teaching materials relevant to students' needs and their socio-cultural environment.

The results of this meta-analysis are expected to not only provide a general overview of the module's effectiveness but also generate applicable recommendations for teachers and policymakers in developing contextual science learning strategies. By prioritizing local wisdom values, the ethnoscience module can serve as a bridge between abstract science material and students' real-life experiences. Therefore, this research not only contributes to strengthening students' academic competencies but also supports the preservation of local culture through education. Therefore, the results of this study are expected to encourage improvements in the quality of science learning in Indonesia in a holistic, culture-based manner, and oriented towards the development of 21st-century scientific literacy.

Based on the background above, the formulation of the problem in this study is: (1) how effective is the use of ethnoscience-based science modules in improving students' scientific literacy? (2) how much is the increase in students' scientific literacy as shown through pretest and posttest scores after using ethnoscience-based science modules? (3) how big is the effect size (Cohen's d) value of the application of ethnoscience-based science modules based on the results of a meta-analysis of eight research articles? So the objectives of this study are: (1) to analyze the effectiveness of the use of ethnoscience-based science modules in improving students' scientific literacy based on the results of a meta-analysis, (2) to find out the average increase in students' scientific literacy scores from the pretest and posttest results after using ethnoscience-based science modules, (3) to calculate the effect size (Cohen's d) value to determine the magnitude of the influence of ethnoscience-based science modules on improving students' scientific literacy.

METHOD

This research was conducted using meta-analysis. Meta-analysis is a statistical technique that combines two or more sets of data from similar studies to obtain quantitative data. From a process perspective, meta-analysis is a retrospective observational study. In this research, a researcher summarizes data without experimental manipulation. The effect size dimensions combined in the meta-analysis must be the same as those reported in the articles to be combined. Meta-analysis involves several research steps: formulating the research problem, collecting literature based on research findings that align with the desired objectives, evaluating the research to gather information, analyzing and interpreting the literature, and finally presenting the meta-analysis results in written form. The design used in this study is to summarize, review, and analyze several previously studied studies that test the effectiveness of ethnoscience-based science modules in improving students' scientific literacy. Meta-analysis research can be found through online journals and Google

Scholar as sources for analysis. The data analysis technique used in meta-analysis research is to search for articles in online journals and Google Scholar as sources for analysis.

From the article search results, eight articles were found with the categories used in this study, namely articles written by general researchers or students, articles used were published in the last 10 years, namely 2016-2025, articles used to analyze the effectiveness of ethnoscience-based science modules in improving students' scientific literacy, the scope of the research area used was in the Indonesian region. From these journals, then analyzed to see the pretest and posttest scores that will be used to measure students' critical thinking skills before and after being given treatment or action. After obtaining the pretest and posttest results, the data was then processed using SPSS 25 for Windows to determine the average and standard deviation of the data so that it can be used to determine the results of the effect size test. The meta-analysis flowchart in this study is as shown in Figure 2.

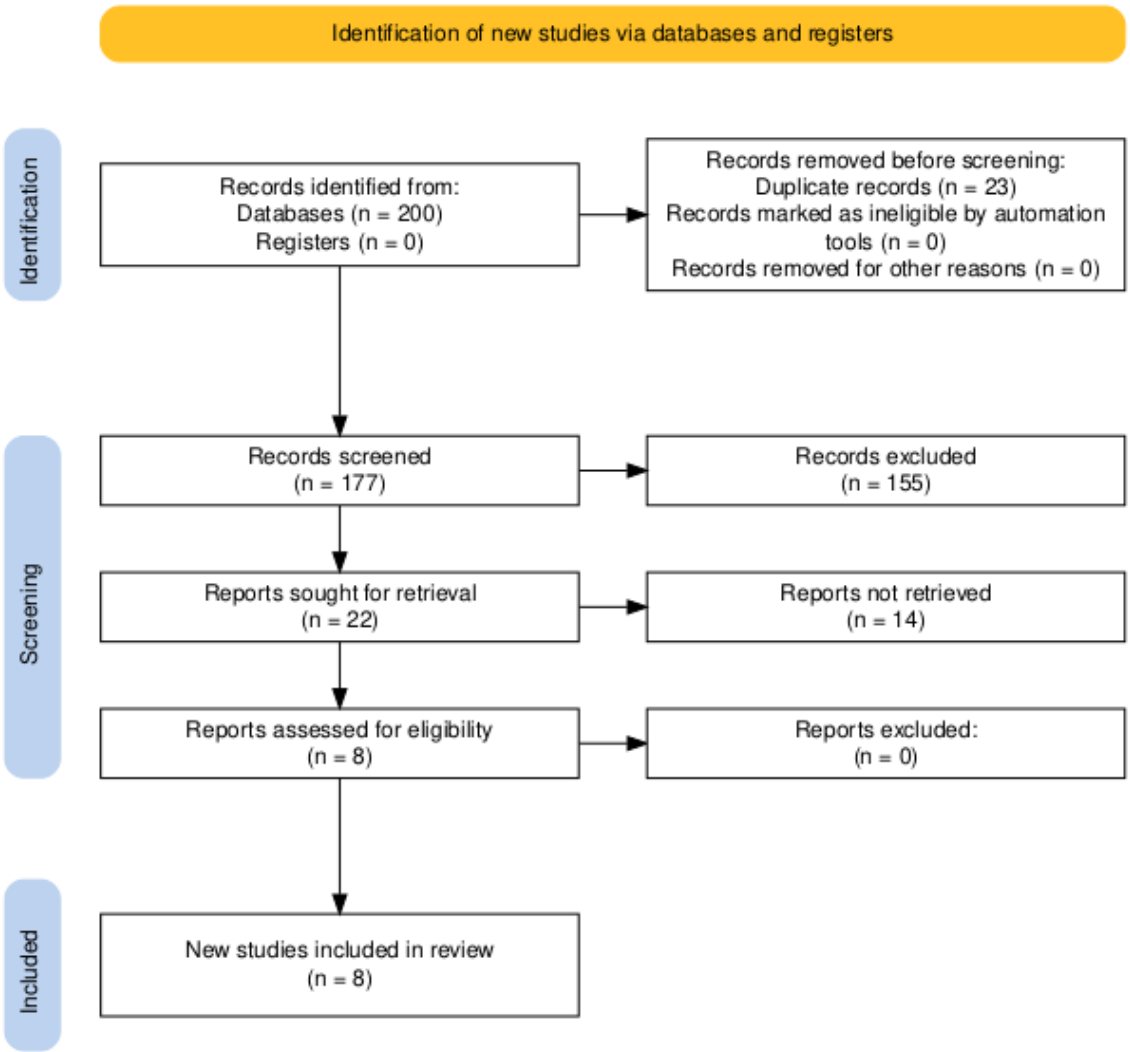

Figure 1. Meta Analysis Flowchart

RESULTS AND DISCUSSION

Results

The initial steps in this research were to define the problem, then conduct a data search through electronic journals on Google Scholar, collecting eight relevant articles for data collection. The pretest and posttest scores from these eight articles are shown in Table 1.

Table 1. Percentage of Increase in Students' Science Literacy with Ethnoscience-Based Science Modules

No	Data Code	Writer	Percentage (%)		
			***Pretest* Score**	***Posttest* Score**	**Improvement**
	A1	Nihwan & Widodo (2020)	35.64	78.18	42.54
	A2	Fatwa & Agustina (2025)	30.00	73.50	43.50
	A3	Perwitasari et al. (2016)	65.40	82.20	16.80
	A4	Sari et al. (2021)	66.40	82.20	15.80
	A5	Ningrum et al. (2024)	37.17	85.83	48.66
	A6	Fitriya et al. (2025)	63.19	92.62	29.43
	A7	Maulida et al. (2022)	23.43	78.36	54.93
	A8	Siagian & Tamba (2023)	36.00	81.43	45.43
Average			**44.65**	**81.79**	**37.14**

Based on Table 1, it is known that the ethnoscience-based science module can improve students' learning literacy in science learning. The average percentage increase in science literacy from the lowest score of 15.80% and the highest score of 54.93% with an average of 37.14%. The average percentage of students' science literacy in the pretest score was 44.65%. The average percentage of students' science literacy in the posttest score was 81.79%. The average percentage before and after using the ethnoscience-based science module increased by 37.14%.

Referring to the data in Table 1, descriptive statistical tests were conducted to determine the mean and standard deviation. The results of the descriptive statistical tests are shown in Table 2.

Table 2. Results of Descriptive Statistical Tests

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Standard Deviation
Pretest	8	23.43	66.40	44.6538	17.42010

Posttest	8	73.50	92.62	81.7900	5.70210
Valid N (listwise)	8				

Table 2 provides information on the characteristics of the pretest and posttest score distributions from the eight articles analyzed. For the pretest data, the minimum score of 23.43 indicates that prior to the intervention of the ethnoscience-based science module, there were students or groups of students with very low levels of scientific literacy. The maximum pretest score of 66.40 also indicates that, although some students had better understanding, the average pretest score of 44.65 indicates that, in general, students' scientific literacy skills were still at a moderate to low level. This is reinforced by the standard deviation of 17.42, indicating significant variation between students or groups in their initial achievements in scientific literacy. Meanwhile, the posttest data showed a significantly better shift in the distribution of scores. The minimum score increased significantly to 73.50, meaning that no students or groups of students had very low levels of scientific literacy after the use of the ethnoscience module. The maximum posttest score reached 92.62, indicating that some students had nearly achieved full mastery of scientific literacy according to the measured indicators. The average posttest score of 81.79 indicates that overall, students' scientific literacy skills were in the high category after the learning process with the ethnoscience module. Not only was there an increase in the average, but the standard deviation value on the posttest also decreased drastically to 5.70. This indicates that student achievement has become more uniform and equitable, and reflects the success of the intervention in reducing the gap in understanding between individuals.

Referring to the average and standard deviation data presented in Table 2, an effect size calculation was performed using the Effect Size Calculator for T-Test website. The purpose of this calculation was to measure the effectiveness of the use of ethnoscience-based science modules in improving students' scientific literacy. Based on the calculation results, Cohen's d value was obtained = 2.865236. This value far exceeds the large effect size limit of 0.80, meaning that the difference between before and after the intervention was statistically significant and practically substantial. This very high Cohen's d value indicates that the use of ethnoscience-based science modules not only provides small or moderate improvements, but also has a significant impact on improving students' scientific literacy. This large effect reflects the module's success in building students' understanding of science in a deeper and more contextual way.

Discussion

The results of this meta-analysis study indicate that the use of ethnoscience-based science modules can significantly contribute to improving students' scientific

literacy. This is evidenced by an increase in the average pretest score of 44.65% to 81.79% in the posttest, representing a 37.14% increase. This increase indicates that modules that integrate local wisdom into science learning can stimulate students' understanding of scientific concepts in a more contextual way. The range of increase from 15.80% to 54.93% indicates that although the results of each study vary, all of them still show a consistent direction, namely a significant increase in students' scientific literacy. The ethnoscience module plays a role not only as teaching material but also as a pedagogical approach that is closer to students' cultural realities. Thus, this approach indirectly strengthens the relevance of learning and student engagement in the science learning process.

The variation in scientific literacy improvement scores from the eight articles indicates that the research results are influenced by various contextual factors, such as student characteristics, teacher implementation of the module, and the local cultural context used in the module. The article with the highest improvement (A7, 54.93%) used an ethnoscience approach that was highly relevant to students' daily experiences, making it easier for students to understand scientific concepts. Conversely, the lowest improvement (A4, 15.80%) was due to limitations in module implementation and the suboptimal integration of cultural values in learning. However, none of the studies showed negative or stagnant results, so it can be concluded that the ethnoscience approach provides improvements in scientific literacy achievement.

Descriptive statistical data from this study provide a clearer picture of the distribution and dispersion of pretest and posttest scores. The pretest mean of only 44.65 with a relatively high standard deviation (17.42) indicates that before the intervention, students' scientific literacy skills tended to be low and varied across studies. However, after the intervention with the ethnoscience module, the posttest mean increased dramatically to 81.79 with a much smaller standard deviation (5.70), indicating that after the learning, scientific literacy achievement became more evenly distributed and standardized. The reduction in the standard deviation value from pretest to posttest also indicates the consistency of the results obtained after the intervention, strengthening evidence that this module is effectively implemented across contexts. This is important because it indicates that the use of the ethnoscience-based module not only improves overall student scores but also reduces the gap in results between students.

Cohen's d value of 2.865 indicates that the effect of using an ethnoscience-based science module is in the very large category. In statistical interpretation, this value far exceeds the general limit of a large effect size of 0.80, which means that the increase in science literacy is not just a small, insignificant change, but rather a significant change worthy of consideration from a practical and policy perspective. This large effect provides strong evidence that the ethnoscience approach is a highly

potential innovative learning strategy. This value also demonstrates the consistency and success of interventions in various research contexts, and strengthens ethnoscience's position as a culture-based pedagogical alternative that is not only socioculturally relevant but also academically effective.

Based on the overall findings, it can be concluded that the ethnoscience-based science module significantly contributes to improving students' scientific literacy and has a high effectiveness value. Theoretically, these results support a constructivist and contextual approach to science learning, where scientific knowledge is built on students' real-life experiences and local culture. Practically, science teachers can begin developing or adapting learning modules based on their respective regional cultures to support student understanding. This research also provides a strong foundation for developing educational policies that integrate local values into the national curriculum, without compromising scientific substance. Going forward, further research is needed with a larger sample size and diverse cultural regions to test the consistent effectiveness of this ethnoscience module. Furthermore, teacher training in designing and implementing ethnoscience-based modules is also an important aspect that requires attention from relevant parties.

Based on the overall findings in this meta-analysis, it can be concluded that the use of ethnoscience-based science modules contributes significantly to improving students' scientific literacy. The consistent increase in pretest to posttest scores across the eight articles analyzed indicates that this approach is effective in helping students understand science concepts more meaningfully. Theoretically, these results reinforce the constructivist approach to science learning, where students construct their knowledge based on their experiences and socio-cultural backgrounds. A contextual approach that links science material to local cultural values has also been shown to increase student engagement in the learning process, as students perceive the learning as being close to their real lives. These findings are also in line with Vygotsky's sociocultural learning theory, which emphasizes the importance of social context in students' cognitive development.

Practically, the results of this study provide a strong foundation for science teachers to begin developing or adapting learning modules integrated with local culture. Teachers can design ethnoscience-based learning by exploring traditional knowledge, local wisdom, or local community practices relevant to the science concepts being taught. This approach not only strengthens students' connection to the subject matter but also helps preserve regional cultural values. Implementing this module also encourages cross-disciplinary learning, as students learn not only about science but also about their own culture, environment, and community. Therefore, schools, as formal educational institutions, can provide support in the form of teacher training, development of teaching materials, and collaboration with community leaders or local cultural experts in designing contextual modules.

The findings of this meta-analysis also provide direction for the development of inclusive and culture-based national education policies. The integration of local values into the science curriculum does not have to contradict the scientific substance, but can instead be an alternative approach that enriches learning methods. Future research is needed with a larger number of articles and samples, and involving representatives from various cultural regions in Indonesia, to obtain a more comprehensive picture of the effectiveness of ethnoscience modules in various contexts. Furthermore, further evaluation should also include implementation aspects, such as teacher readiness, module quality, and student responses, so that the results can be used as concrete policy recommendations. Intensive training for teachers in designing and implementing ethnoscience-based modules is also an urgent need that must be facilitated by local and central governments.

CONCLUSION

Based on the results of a meta-analysis of eight relevant articles, it can be concluded that the use of ethnoscience-based science modules has proven effective in improving students' scientific literacy. The average increase of 37.14% from pretest to posttest scores indicates that the ethnoscience approach is able to strengthen the understanding of science concepts through the integration of local culture that is relevant to students' lives. The effect size value (Cohen's d = 2.865) indicates a very high level of effectiveness, which not only improves learning outcomes but also equalizes achievement among students. Theoretically, these results support constructivist and contextual learning, while practically, they provide a strong basis for teachers and policymakers to develop culture-based modules that are appropriate to the characteristics of their respective regions. To strengthen these findings, it is recommended that further research be conducted with a larger number of articles and a broader cultural scope for more representative results. In addition, further research can explore in more depth the factors that influence the successful implementation of ethnoscience modules, such as teacher competence, student engagement, the quality of module design, and the diversity of socio-cultural contexts. It is also recommended that there be empirical tests that directly compare ethnoscience modules with conventional learning approaches over a longer period of time.

BIBLIOGRAPHY

Dian, E.S. (2022) *Pengembangan Modul Pembelajaran IPA Berbasis Etnosains Pada Materi Gerak Untuk Meningkatkan Literasi Sains Pada Siswa Kelas IV SD*. Universitas Muhammadiyah Mataram.

Fatwa, Z.P. and Agustina, P. (2025) 'Pengaruh Penggunaan E-Modul Berbasis SSI Terhadap Literasi Sains dan Hasil Belajar IPA Siswa Kelas VII SMPN 5 Sukoharjo Tahun Ajaran 2024/2025', *ORYZA: Jurnal Pendidikan Biologi*, 14(1), pp. 1–11.

Fitriya, Maiyanti, A.A. and Syamsudin, H.A. (2025) 'Efektivitas Modul Pembelajaran IPA Berbasis Etnosains Dalam Meningkatkan Aspek Sikap Sains', *Jurnal Pendidikan Indonesia: Teori, Penelitian dan Inovasi*, 5(2), pp. 28–33.

Maulida, N., Saadi, P. and Bakti, I. (2022) 'Efektifitas Modul Elektronik South Kalimantan Foody Dalam Melatihkan Kemampuan Literasi Sains Peserta Didik Pada Materi Hidrolisis Garam', *QUANTUM: Jurnal Inovasi Pendidikan Sains*, 13(1), pp. 64–74.

Muizz, A., Suryanti and Prahani, B.K. (2023) 'Literature Review: Penggunaan Modul IPA Berbasis Etnosains untuk Meningkatkan Literasi Sains pada Siswa SD', *Elementaria Edukasia*, 6(4), pp. 1905–1914.

Nihwan, M.T. and Widodo, W. (2020) 'Penerapan Modul IPA Berbasis Etnosains Untuk Meningkatkan Kemampuan Literasi Sains Siswa SMP', *Pensa E-Jurnal: Pendidikan Sains*, 8(3), pp. 288–298.

Ningrum Syifa Nur, Yulinda Ratna, S. (2024) 'Pengembangan Modul Ajar IPA SMP Berbasis Problem Based Learning Untuk Meningkatkan Literasi Sains Peserta Didik Jurnal Teknologi Pendidikan Dan Pembelajaran (JTPP)', *Jurnal Teknologi Pendidikan dan Pembelajaran (JTPP)*, 01(04), pp. 693–698.

Pardianiati, I., Susongko, P. and Munadi, M. (2025) 'Validitas E-modul Zat Aditif Berbasis Etnosains untuk Melatih Literasi Sains Peserta Didik', *Pancasakti Science Education Journal*, 10(1), pp. 1–7.

Perwitasari, T., Sudarmin and Linuwih, S. (2016) 'Peningkatan Literasi Sains Melalui Pembelajaran Energi Dan Perubahannnya Bermuatan Etnosains Pada Pengasapan Ikan', *JPPIPA: Jurnal Penelitian Pendidikan IPA*, 1(2), pp. 62–70.

Sari, E., Setiawan, D. and Ayu, I. (2021) 'Peningkatan Literasi Sains Melalui Pembelajaran Energi Dan Perubahannya Bermuatan Etnosains Pada Pengasapan Ikan', *Panthera: Jurnal Ilmiah Pendidikan Sains dan Terapan*, 1(1), pp. 25–36.

Siagian, I.R. and Tamba, R. (2023) 'Pengembangan Modul Ipa Berbasis Etnosains Pada Materi Sumber Energi Untuk Meningkatkan Literasi Siswa Sekolah Dasar', *PASCAL (Journal of Physics and Science Learning)*, 7(2), pp. 67–74. Available at: https://doi.org/10.30743/pascal.v7i2.8541.