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Enhancing Elementary School Students' Understanding of the Nature of Science and their Environmental Awareness through Ethnoscience-Based E-Worksheets

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Abstract

The Nature of Science (NoS) and Environmental Awareness (EA) are fundamental components in fostering scientific thinking and responsible environmental behavior. However, previous studies indicate that elementary students' understanding of both aspects remains low. Science instruction in schools often emphasizes memorization, and existing worksheets are generally conventional and lack integration of ethnoscience, connecting cultural practices with scientific concepts. This gap highlights the need for culturally relevant digital learning materials. The novelty of the study lies in the development and evaluation of a validated ethnoscience-based E-Worksheet designed to enhance students' NoS and EA through contextualized and meaningful learning experiences. The study analyzed the effect of E-Worksheet on elementary students in Bandar Lampung, following expert validation. Data were obtained from 30 purposively selected students whose schools implemented the E-Worksheet, meeting the minimum sample requirements for the Structural Equation Modeling–Partial Least Squares (SEM-PLS) analysis conducted using SmartPLS 4. The analysis obtained an R^2 value of 0.778, indicating that the ethnoscience-based E-Worksheet simultaneously affects students' NoS and EA. These findings demonstrate that validated ethnoscience-integrated digital worksheets can effectively strengthen scientific reasoning and environmental responsibility in elementary education, emphasizing the importance of incorporating culturally relevant digital materials into science learning. The findings were supported by validated NoS and EA questionnaires developed through literature review and expert judgment.

Keywords: E-Worksheet, Environmental Awareness, Nature of Science, SEM-PLS

Abstrak

Sifat Ilmu Pengetahuan (NoS) dan Kesadaran Lingkungan (EA) sangat penting dalam mengembangkan pemikiran ilmiah dan sikap lingkungan yang bertanggung jawab, penelitian sebelumnya menunjukkan bahwa siswa sekolah dasar masih memiliki pemahaman yang rendah di kedua bidang tersebut. Pembelajaran sains di sekolah sering kali menekankan pada hafalan, dan lembar kerja yang ada masih konvensional tanpa mengintegrasikan unsur-unsur etnosains yang menghubungkan pengalaman budaya dengan konsep-konsep ilmiah. Kesenjangan ini menyoroti kebutuhan akan bahan ajar digital yang relevan secara budaya. Oleh karena itu, penelitian ini menawarkan inovasi dengan mengembangkan dan menguji lembar kerja digital berbasis etnosains yang valid, dirancang untuk meningkatkan pemahaman siswa tentang NoS dan EA dalam lingkungan belajar yang lebih kontekstual dan bermakna. Penelitian ini menganalisis dampak lembar kerja digital berbasis etnosains yang telah divalidasi terhadap pemahaman siswa sekolah

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dasar di Bandar Lampung tentang NoS dan EA. Analisis dilakukan setelah memastikan bahwa lembar kerja digital memenuhi kriteria validasi ahli. Menggunakan metode Structural Equation Modeling–Partial Least Square (SEM-PLS) melalui SmartPLS 4, data dikumpulkan dari 30 siswa yang dipilih secara purposif dari sekolah yang telah menerapkan lembar kerja digital. Meskipun populasi besar, sampel memenuhi persyaratan PLS-SEM untuk daya statistik minimum. Hasil menunjukkan nilai R-square sebesar 0.778, menunjukkan bahwa Lembar Kerja Elektronik secara bersamaan mempengaruhi NoS dan EA siswa. Temuan ini menunjukkan bahwa Lembar Kerja Elektronik berbasis etnosains yang telah divalidasi dapat efektif.

***Kata kunci**: E-LKPD, Kesadaran Lingkungan, Nature of Science, SEM-PLS*

INTRODUCTION

The concept of the Nature of Science (NoS) has regained prominence in the science education community and is widely recognized as a key component of scientific literacy. Understanding NoS is considered essential for developing students' scientific literacy, and numerous science education frameworks—such as those issued by the American Association for the Advancement of Science and the National Research Council—highlight its critical role in enriching learners' educational experiences (Boran & Bağ, 2016; Önal & Eryaşar, 2022; Soysal, 2015; Hogan & O'Flaherty, 2022). Mastery of NoS is important in enabling individuals to create, manage, and respond to scientific and technological developments (Lederman, Lederman, & Antink, 2013; Gede, Juni Pratama, Dantes, & Yudiana, 2020). It also supports informed decision-making on socio-scientific issues and fosters an appreciation of science as a vital aspect of contemporary culture. Considering the significance of NoS understanding for learners, research on how NoS is taught and assessed remains essential (Widiastuti & Priantini, 2022; Sengul, 2023; Eastwell, 2002).

Understanding the Nature of Science (NoS) enables learners to develop reasoning skills, scientific thinking, and the ability to apply scientific knowledge in real-world contexts. It also cultivates the positive attitudes necessary for navigating the challenges of contemporary society. Thus, NoS represents an essential educational foundation rather than a supplementary component of academic content, particularly in the current era characterized by globalization and rapid advancements in science and technology (BouJaoude, Ambusaidi, & Salloum, 2021; Sunyono & Meristin, 2023; Imran & Wibowo, 2018).

The globalization era also brings broader societal challenges, including persistent gaps in scientific literacy, escalating environmental degradation, and issues related to food security—each of which constitutes a strategic global concern (Fauziah & Hamdu, 2022; Pratiwi, Sunyono, Rohman, & Firdaus, 2024). These challenges are exacerbated by population growth, which increases pressure on environmental quality and heightens the demand for sufficient food resources (Sri Widi Astuti, 2016; Kristyowati, 2018). Environmental problems—particularly those related to waste generation and management—have intensified as population growth and increased consumption continue to produce substantial amounts of waste, ultimately contributing to environmental pollution (Amtonis, 2022). A lack of environmental responsibility and awareness further exacerbates these issues. When individuals fail to appreciate and care for their surroundings, behaviors such as littering, vandalism, and environmental degradation become more prevalent, posing serious risks to ecosystem stability. These conditions highlight the urgency of preventive measures through effective environmental education (Pratiwi et al., 2024; Sunyono & Meristin, 2023).

Education plays an important role in fostering students' Environmental Awareness as part of broader efforts to preserve ecological sustainability (Krajhanzl, 2010; Marpa, 2020). Nevertheless, current educational practices indicate that many students still demonstrate limited awareness and responsibility toward environmental issues, despite the increasing severity of environmental challenges. This condition highlights the need for the education system to adopt innovative and contextually relevant approaches—particularly in the era of the Industrial Revolution 4.0, where technology-enhanced and internet-based learning has become essential for addressing students' evolving needs (Amtonis, 2022; Sabaruddin, 2022). In the competitive landscape of 21st-century education, the younger generation must be equipped not only with academic knowledge but also with strong character and essential life skills. Thus, educational innovations that integrate technology with environmental values are urgently required. Key competencies for 21st-century learners include creativity, critical thinking, communication, and collaboration (Sunyono, Viyanti, & Efendi, 2023; Pramudiyanti, Pratiwi, Armansyah, Rohman, & Putri, 2023). Rapid technological advancement brings both positive opportunities and potential risks. To mitigate the negative impacts of technological development, education must be positioned as a strategic instrument for supporting sustainable development (Rohman & Lusiyana, 2017). Such sustainable development encompasses academic, psychological, economic, environmental, and social dimensions (Hogan & O'Flaherty, 2022; Saputro & Pakpahan, 2021).

This study examines the influence of an ethnoscience-based E-worksheet as a digital learning material designed to improve students' understanding of the Nature of Science (NoS) and Environmental Awareness (EA). The integration of this material is crucial, as previous research indicates that conventional worksheets often fail to link scientific concepts with students' cultural contexts, resulting in limited conceptual understanding and weak relevance to real-world issues. The ethnoscience-based E-worksheet addresses this gap by integrating local wisdom within digital learning resources, thereby providing students with more contextualized and meaningful learning experiences.

The novelty of this study lies in its examination of the dual impact of an ethnoscience-based E-worksheet on both NoS and EA—two constructs that have seldom been investigated concurrently within a single instructional framework. Furthermore, this research explores whether students' understanding of NoS contributes to the enhancement of their environmental awareness.

METHOD

This study employed a quantitative approach using questionnaires and Structural Equation Modeling–Partial Least Squares (SEM-PLS) for data analysis (Siti Nur Ufudiah, Supardi, & Machdum Bachtiar, 2022; Sayyida & Alwiyah, 2018). The questionnaire consisted of closed-ended items developed from validated indicators of NoS and EA. Closed-ended items were selected to ensure response consistency and to support the statistical requirements of SEM-PLS. Data were collected online through a secure Google Form link to provide flexibility, reduce researcher bias, and facilitate efficient distribution across participating schools. Prior to administration, the instrument underwent expert judgment and pilot testing to ensure clarity, reliability, and construct validity.

SEM-PLS was employed because the data in this study were not assumed to be normally distributed, making it more appropriate than regression techniques that depend on Best Linear Unbiased Estimates (BLUE). In addition, SEM-PLS was appropriate for studies aimed at predicting latent variables and examining several structural relationships simultaneously among multiple constructs. This study adopted a non-experimental causal–associative design to investigate the relationships among the ethnoscience-based E-Worksheet, NoS, and EA. As the study did not involve experimental treatment, manipulation, or the use of a control group, the term "effect" was replaced with "relationship" or "influence" to accurately represent the nature of the research design. The research procedure was carried out in three stages, namely:

Identification Stage

This stage involved reviewing relevant literature, examining real-world classroom

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conditions, identifying existing problems, determining the objectives of the study, selecting appropriate strategies to address the identified issues, and developing the research instruments.

Data Collection Stage

This study employed the PLS-SEM approach for data analysis. According to Ghozali and Latan, PLS-SEM is suitable for studies with relatively small sample sizes, with a recommended minimum of 30 to 100 pieces of information (Sayyida & Alwiyah, 2018). Matthews et al. (2018) further note that the "ten-times rule" can be used to estimate the minimum sample size by multiplying the largest number of structural paths directed at a particular latent variable by ten, whether these paths represent formative indicators or structural relationships (Matthews, Hair, & Matthews, 2018). In this study, the maximum number of structural paths directed toward an endogenous variable was three; therefore, the minimum required sample size was $10 \times 3 = 30$.

Although many SEM-PLS guidelines recommend larger sample sizes (typically >100) to enhance statistical power, smaller samples (<100) may still be appropriate depending on the research context, measurement model complexity, and availability of participants. The present study involved 30 students who had used the ethnoscience-based E-Worksheet at SDN 1 Pinang Jaya. This sample size met the minimum requirement proposed by Sayyida and Alwiyah (2018), who emphasize that SEM-PLS remains robust under small-sample conditions because it does not assume multivariate normality and is well suited for exploratory and predictive modeling.

Data Processing Stage

The data processing stage was conducted after recapitulating respondent information, including comprehension levels, gender, and science specialization, all of which could influence students' understanding of NoS and EA. The data processing procedure consisted of two stages, namely:

Data collection instrument

Data collection instruments played a critical role in ensuring the accuracy, objectivity, and validity of the research data. Therefore, prior to data collection, the instruments developed in this study were tested for validity and reliability. The research employed closed-ended questionnaires comprising two separate scales: one measuring students' understanding of the Nature of Science (NoS) and the other measuring Environmental Awareness (EA). In total, the instrument consisted of two questionnaires with 30 items each, developed based on theoretical indicators and adapted from previously validated instruments.

Validity testing

The validity test was conducted to determine whether the questionnaire items accurately measured the intended variables. A valid instrument is one that is capable of collecting data that correctly reflects the construct being measured (Khairunisa et al., 2025). In other words, validity indicates the extent to which an instrument measures what it is designed to measure. This study employed content validity through item analysis by examining the correlation between each item score and the total score. Based on the criteria proposed by Ranganathan et al. (2024), an item was classified as valid if the r-count > r-table, indicating the item is valid; and r-count < r-table, indicating the item is invalid.

The validity testing was performed using SPSS, where the Corrected Item–Total Correlation value served as the r-count. For 30 respondents at a significance level of $\alpha = 0.05$, the r-table value was 0.361.

Reliability testing

The reliability test was conducted to determine the consistency of the data collection instrument. Reliability was assessed using Cronbach's Alpha, which is widely used to evaluate the internal consistency of questionnaire items (Yusup, 2018). The interpretation of reliability was based on the following criteria:

- α = 0.80–1.00 → indicates high reliability
- α = 0.60–0.799 → indicates moderate reliability
- α < 0.60 → indicates low reliability

An instrument was considered reliable if the Cronbach's Alpha value exceeded **0.60**, signifying that the items consistently measured the intended construct.

SEM–PLS data processing

Structural Equation Modeling (SEM) is a statistical technique used to evaluate the fit of hypothesized causal–effect relationships within a model (Wala, Alim, & Fardanto, 2020). When SEM is applied, the primary objective is to assess whether the proposed model is conceptually sound and empirically supported (Khairi, Susanti, & Sukono, 2021; Hair et al., 2021). SEM enables the analysis of relational structures, causal pathways, and the adequacy of measurement models (Hair et al., 2021).

Structural Equation Modeling–Partial Least Squares (SEM-PLS) is a variance-based SEM approach used to evaluate linear relationships among latent variables, particularly when the constructs cannot be directly observed or measured (Achjari, 2004). The evaluation of an SEM-PLS model typically involves two components:

Measurement Model Evaluation (Outer Model)

This stage aimed to ensure that the measurement indicators used in the model were accurate and consistent. The evaluation of the measurement model was conducted through several reliability and validity tests. Convergent validity was assessed by examining factor loadings, which were required to exceed 0.70. Discriminant validity was evaluated using cross-loading values, which also needed to be greater than 0.70. Internal consistency reliability was examined using Cronbach's Alpha and Composite Reliability, both of which were expected to have values above 0.70 (Amirul & Nasution, 2024; Ngurah, Paramartha, Yanuar, & Syah, 2020).

Structural Model Evaluation (Inner Model)

The purpose of evaluating the structural model was to determine the relationships among latent variables based on established theoretical frameworks. This evaluation involved examining the model's predictive capabilities and the significance of the causal paths. Key indicators assessed in this stage covered the Coefficient of Determination (R^2), Path Coefficients, T-Statistics, Predictive Relevance (Q^2), and Effect Size (f^2) (Fatmawati & Nurhidayati, 2022; Mardiana & Faqih, 2019).

RESULT AND DISCUSSION

The E-Worksheet, Nature of Science, and Environmental Awareness variables—each consisting of three items—were tested for validity and reliability involving 30 students. All items met the validity criteria, as the r-count is higher than the r-table. They also met the reliability criteria, with Cronbach's alpha values above 0.70. Therefore, the questionnaire was considered suitable for distribution to eligible respondents.

A primary SEM-PLS model consisting of nine statement items was developed using data from the questionnaire summary. The PLS-Algorithm procedure was then applied to obtain the Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) values. These calculations require several steps, including checking the outer loadings to assess convergent validity, as presented in Table 1. Any item with an outer loading value below 0.70 was removed from the model.

Volume 11 No. 2, December 2025
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Measurement Model Evaluation (Outer Model)

One of the prerequisites for using data in the SEM method is that the dataset must be free from outliers. Outliers are data with unique characteristics that differ substantially from the rest of the data and typically appear as extreme values in either individual variables or combinations of variables (Ghaharian et al., 2023; Ringle, Sarstedt, Sinkovics, & Sinkovics, 2023).

Results of Convergent Validity Testing

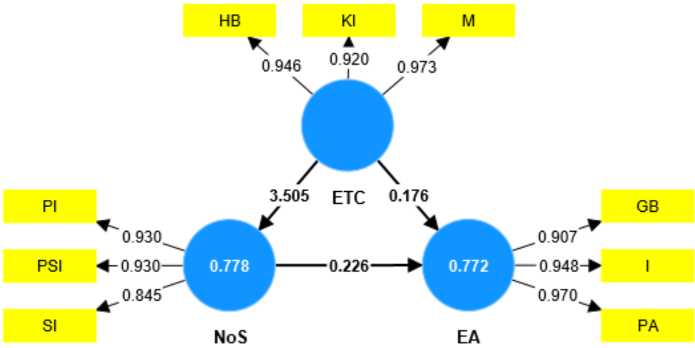

Figure 1. Results of Convergent Validity Testing

Table 1. Outer loading values

Variables	Indicator	Loading Factor	AVE
ETC	KI	0.920	0.897
	M	0.973	
	HB	0.946	
NoS	PI	0.930	0.815
	PSI	0.930	
	SI	0.845	
EA	GB	0.907	0.887
	I	0.948	
	PI	0.970	

Table 1 shows that all items have outer loading values above 0.70. All variables show AVE values greater than 0.50. Therefore, every indicator meets the criteria for convergent validity (Komara & Fathurahman, 2024; Haryono, 2016).

Results of Discriminant Validity Testing

Table 2. Fornell Larcker value

	EA	ETC	NoS
EA	0.942		
ETC	0.849	0.947	
NoS	0.856	0.882	0.903

Table 2 shows that the square root of each construct's AVE exceeds its correlations with all other constructs. This indicates that the measurement model meets the discriminant validity criterion (Haryono, 2016).

Results of Reliability Testing

Table 3. Cronbach's Alpha and Composite Reliability values

	Cronbach's alpha	Composite reliability (rho_c)
EA	0.936	0.959
ETC	0.942	0.963
NoS	0.887	0.929

Table 3 shows that both Cronbach's alpha and composite reliability values for all variables are higher than 0.70. Therefore, it can be concluded that all variables are reliable (Haryono, 2016).

Results of Structural Model Evaluation (Inner Model)
R-Square Values

Table 4. R-Square and Adjusted R Square values

	R-square	R-square adjusted
EA	0.772	0.756
NoS	0.778	0.770

Table 4 shows that the R-square (R^2) value for the EA variable is 0.772, indicating that the ETC and NoS variables jointly explain 77.2% of the variance in EA. As this value is higher than 0.67, the model is considered strong (Haryono, 2016).

Similarly, the R^2 value for the NoS variable is 0.778, demonstrating that the ETC variable explains 77.8% of the variance in NoS. As this value is also greater than 0.67, the model is considered strong (Haryono, 2016).

F-Square Values

Table 5. F-Square Values

	EA	NoS
ETC	0.176	3.505
NoS	0.226	

Table 5 shows that the F-square *(*f^2) value for the effect of ETC on EA is 0.176, which falls within the range of 0.15–0.34. This indicates that ETC has a moderate effect on EA. The f^2 value for the effect of ETC on NoS is 3.505, which is higher than 0.35, meaning that ETC has a strong effect on NoS.

Meanwhile, the f^2 value for the effect of NoS on EA is 0.226, which is also within the 0.15–0.34 interval, indicating that NoS has a moderate effect on EA.

GoF Index

Table 6. AVE and R-Square values

	AVE	**R-Square**
ETC	0.897	
NoS	0.815	0.778

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EA	0.887	0.772
Average	**0.866**	**0.775**

$$\text{GoF Value} = \sqrt{\text{Average AVE x Average R} - \text{Square}}$$

$$\text{GoF Value} = \sqrt{0.866 \text{ x } 0.775}$$

$$\text{GoF Value} = 0.819$$

Based on the calculation results, the GoF value obtained is 0.819, which is higher than 0.36. This indicates that the combined performance of the outer and inner models in this study falls within the large GoF category**,** demonstrating strong overall model suitability (Haryono, 2016).

Results of Hypothesis Testing

Table 7. Results of Hypothesis Testing

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P-values
ETC -> EA	0.424	0.410	0.210	2.019	0.044
ETC -> NoS	0.882	0.881	0.056	15.617	0.000
NoS -> EA	0.482	0.491	0.207	2.322	0.020
ETC -> NoS -> EA	0.425	0.431	0.189	2.248	0.025

The ETC → EA path obtained a t-value of 2.019, which is higher than 1.96. The corresponding path coefficient is positive, indicating that H_0 is rejected and H_a is accepted. Thus, ETC has a positive and statistically significant effect on EA. This result implies that higher levels of ETC are associated with increased EA among students.

Moreover, the analysis of the exogenous construct demonstrates that the ethnoscience-based E-Worksheet significantly contributes to students' Environmental Awareness, as reflected by a p-value of 0.044 (< 0.05). These findings confirm that the ethnoscience-based E-Worksheet plays a substantive role in strengthening students' understanding and awareness of environmental issues.

This positive effect can be attributed to the distinctive characteristics of the ethnoscience-based E-Worksheet. The E-Worksheet integrates elements of local cultural knowledge, traditional ecological wisdom, and community-based environmental practices into the learning process. By contextualizing environmental concepts through examples drawn from students' immediate surroundings—such as local conservation efforts, traditional resource-management systems, and cultural norms related to nature—the E-Worksheet enhances students' emotional and cognitive connection to their environment. This culturally grounded approach increases the relevance, meaningfulness, and real-world applicability of environmental issues, thereby fostering greater environmental awareness.

Furthermore, the E-Worksheet's interactive features—such as inquiry tasks, reflection prompts, and problem-solving activities—promote active engagement with environmental issues and encourage students to consider their role in environmental protection. This blend of cultural relevance and active learning strengthens students' understanding of ecological concepts, thereby contributing to the significant positive effect of the ethnoscience-based E-Worksheet on Environmental Awareness.

The analysis indicates that the ETC → EA pathway is statistically significant, with a p-value of 0.044 (< 0.05). This confirms a meaningful relationship between ETC and EA within the structural model. The positive coefficient (original sample) further demonstrates that the ethnoscience-based E-Worksheet exerts a positive and significant influence on students' Environmental Awareness. These findings align with previous research emphasizing the role of ethnoscience integration in fostering student character development (Agboola & Tsai, 2012). Similar perceptions have been reported by chemistry teachers in NTB, who highlight the importance of ethnoscience-oriented learning in shaping students' character and values (Andayani, Anwar, & Hadisaputra, 2021; Agung, Trisna, Andayani, Arian, & Anwar, 2022). By embedding subject matter within local cultural values, ethnoscience-based learning can contribute to strengthening students' character (Iasha, 2022; Birhan, Shiferaw, Amsalu, & Tamiru, 2021).

The second hypothesis was supported by the structural model results, which showed that the ethnoscience-based E-Worksheet had a significant positive effect on Environmental Awareness ($t = 2.019 > 1.96$). Thus, H_0 is rejected and H_a is accepted, confirming that ETC significantly enhances EA. This finding aligns with previous studies indicating that factors such as student activity, interest, usefulness, and the appeal of the E-Worksheet contribute to its effectiveness (Pratiwi et al., 2024; Mahyuny et al., 2022). The integration of ethnoscience—viewed as a cultural system, activity, and artifact—also supports character development by embedding community values and norms into learning (Mukti, Suastra, & Aryana, 2022; Sari, Maryati, & Wilujeng, 2023).

The ETC → NoS pathway was found to be statistically significant, with a t-value of 15.617 (> 1.96), a p-value of 0.000 (< 0.05), and a positive coefficient. Thus, H_0 is rejected and H_a is accepted, indicating that the ethnoscience-based E-Worksheet has a positive and significant effect on students' understanding of Nos. This finding aligns with the notion that ethnoscience-based learning draws on cultural knowledge as a fundamental component of education, serving as a medium for expressing ideas and fostering scientific understanding (Hastuti, Setianingsih, & Widodo, 2022; Pertiwi, Solfarina, & Langitasari, 2021).

The first hypothesis is supported, indicating that the ethnoscience-based E-Worksheet has a significant positive effect on students' understanding of NoS. This is evidenced by a t-value of 15.617 (> 1.96), a p-value of 0.000 (< 0.05), and a positive coefficient. Thus, H_0 is rejected and H_a is accepted. This suggests that increased use of the ethnoscience-based E-Worksheet enhances students' understanding of NoS. This finding is consistent with previous studies showing that E-Worksheets contribute to the development of students' NoS (Miller, Montplaisir, Offerdahl, Cheng, & Ketterling, 2010; Nugroho & Iriani, 2020). The effectiveness of the E-Worksheet is supported by its integration of culture-based learning and real-life contexts, aligning with research demonstrating that ethnoscience-based learning tools can strengthen scientific literacy and understanding (Kriswanti, Suryanti, & Supardi, 2020; Wijayanti, Puspita, & Nurmalasari, 2022; Sholikhah & Sudibyo, 2021).

The analysis indicates that the structural path from the Nature of Science (NoS) to Environmental Awareness (EA) is statistically significant and positively directed. This is evidenced by a t-value of 2.322, which is higher than 1.96, and a p-value of 0.020, which is below the significance level of 0.05. The positive path coefficient further demonstrates that a stronger understanding of NoS is associated with higher levels of Environmental Awareness among students. These findings support the rejection of the null hypothesis and confirm that NoS has a meaningful and significant influence on students' Environmental Awareness. This result emphasizes the importance of integrating NoS-oriented instruction to foster deeper environmental understanding and responsible environmental attitudes.

The findings of this study demonstrate a significant positive influence of the Nature of Science (NoS) on Environmental Awareness (EA). This relationship reinforces the view that science education extends beyond the delivery of conceptual knowledge; it also encompasses the processes through which scientific information is generated and the cultivation of scientific attitudes (Artaga,

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2021; Verawadina, Jalinus, & Asnur, 2019). Learning science as a process has the potential to strengthen students' scientific process skills, while learning science as an attitude contributes to the formation of behaviors and characters that reflect care, responsibility, and ethical awareness toward oneself, society, and the broader environment (Tanti et al., 2020; Mukti, Rahmawati, & Marzuki, 2022).

The mediation analysis further reveals that the path from Ethnoscience-Based E-Worksheet (ETC) through NoS to EA is statistically significant, with a t-value of 2.248 (> 1.96), a p-value of 0.025 (< 0.05), and a positive path coefficient. Thus, H_0 is rejected and H_a is accepted, confirming that ETC has a positive and significant indirect effect on EA through NoS.

CONCLUSION

The study demonstrates that the ethnoscience-based E-Worksheet significantly improves fifth-grade students' understanding of the Nature of Science (NOS) and their Environmental Awareness (EA), jointly accounting for over 77% of the observed variance. Students with stronger NOS understanding also show higher environmental awareness, suggesting that scientific reasoning is closely associated with environmentally responsible behavior. The integration of ethnoscience—rooted in local cultural knowledge and traditional ecological practices—made learning more contextual and relevant, thereby enhancing both scientific comprehension and environmental sensitivity. Despite these promising outcomes, the study is limited by its small sample size, short intervention duration, and variations in students' prior knowledge. Future studies should include larger and more diverse samples, longer implementation periods, and additional variables to broaden the applicability of the findings. Overall, the results affirm that culture-based digital learning materials are an effective approach for promoting scientific literacy and environmental awareness among elementary students.

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