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Improving student chemistry laboratory performance through Nyamplung ethnoscience-oriented learning of the *Sasak* tribe

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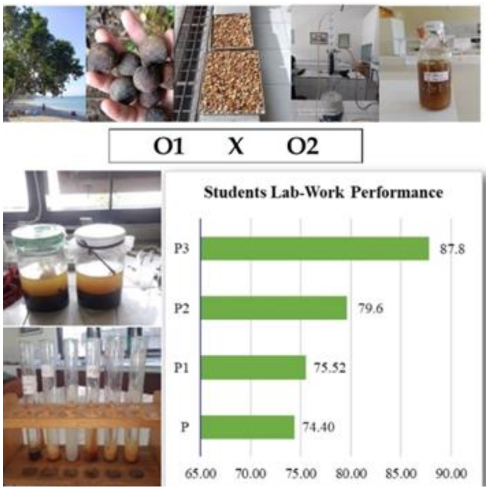
Abstract

Evaluating student performance in open-ended laboratory settings presents challenges compared to the structured format of typical lab exercises, which often resemble recipes. This study aims to enhance student performance by integrating local ethnoscience into chemistry education, using the Nyamplung tree (*Calophyllum inophyllum* L.), part of the Sasak tribe's knowledge, as teaching material. The study employed a pre-experimental pretest-posttest design with 17 chemistry students participating in three lab sessions. All course participants were selected as research subjects using purposive sampling. Performance was assessed through portfolios, and the N-gain method was used to analyze improvement. Results showed consistent performance increases, with scores rising from 75.52 to 87.76 over three sessions and N-gain values indicating positive but low-category improvement (0.015, 0.070, 0.181). These findings suggest that integrating ethnoscience-based materials can improve student performance while offering a culturally relevant learning experience.



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1. ethnoscience integration;
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4. Nyamplung tree (*Calophyllum inophyllum L.*);
5. *Sasak* indigenous knowledge.

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Highlights

- Innovation skills and chemical concept mastery are linked to student learning.
- Positive correlation between Motivation, teaching strategies, and curriculum design.
- To uncover how innovation/chemistry education intertwines, 31 studies were revised.
- Innovative teaching methods enhance innovation skills and concept mastery.
- Comprehensive insights into the impact of

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1. Introduction

As an archipelagic country rich in multicultural diversity, Indonesia must preserve these values by maintaining the nation's noble heritage. National education aims to develop students' potential by transferring cultural values and excellence, helping them become stewards and innovators of the nation's culture (Ministry of Education and Culture, 2012). Through education, students learn, study, and develop cultural values and practices from the past, adapting them to modern society and the world the student live in (Fasasi, 2017a; Kusniati, 2012; Okechukwu *et al.*, 2014; Rist and Dahdouh-Guebas, 2006). Students can inherit and develop culture effectively if their knowledge, intellectual abilities, attitudes, habits, and social skills provide a strong foundation for their growth as individuals and members of society (Lee *et al.*, 2012; Tauro *et al.*, 2021).

Schools teach various subjects based on the applicable curriculum, including chemistry. Chemistry education helps students understand facts, solve problems, use laboratory skills, and behave scientifically. However, chemistry education often focuses too much on pure science, leaving students unable to see science as part of a broader system that integrates with the environment, technology, and society (Fitria and Widi, 2015). Integrating ethnoscience into chemistry lessons can give students a holistic understanding of how scientific principles connect to their cultural and environmental context (Hastuti *et al.*, 2019; Pieter and Risamasu, 2024). This approach not only enhances students' appreciation of the relevance of science in everyday life but also fosters critical thinking by linking indigenous knowledge to scientific concepts (Yazidi and Rijal, 2024; Zidny and Eilks, 2018).

Culturally oriented learning is crucial, particularly in connecting students to their local environment and heritage. One approach to culturally oriented learning is ethnoscience, which studies knowledge systems derived from cultural practices and natural phenomena. Ethnoscience provides valuable insights into how communities understand the world around them. For example, the Sasak tribe of Lombok has developed unique ethnoscientific knowledge that can be integrated into science education (Dewi *et al.*, 2019). Traditions such as the Sasak house of Sade village, mopping with cow dung, the Bau Nyale festival, "*sesek weaving, gendang belek, poteng reket, and dilah jojor"* offer rich learning opportunities (Hikmawati *et al.*, 2020; Mashami *et al.*, 2023). Among these, one particularly unexplored yet promising ethnoscientific resource for science education is the Sasak community's use of the Nyamplung plant.

Nyamplung in Sasak Society is utilized in three main aspects. First, as raw material for making *dile jojor*. *Dile jojor* Nyamplung is a type of torch whose raw material is made from Nyamplung fruit and is part of the Maleman tradition of the Sasak community (Hayadi, 2021; Khery *et al.*, 2022; Mashami *et al.*, 2023). Traditional bamboo torch lighting equipment generally uses kerosene (fossil fuel) which is not renewable, while Nyamplung oil can be renewed. This shows that Nyamplung seed oil holds potential as a renewable fuel. Many studies have studied the potential of Nyamplung seed oil into biodiesel and biofuel (Ansori *et al.*, 2019; Chasani *et al.*, 2015; Dewajani *et al.*, 2016; Fadhlullah *et al.*, 2015; Handayani *et al.*, 2017; Kurniati *et al.*, 2018). Making biodiesel from Nyamplung oil generally applies a transesterification reaction (Musta *et al.*, 2017; Muhammad *et al.*, 2017; Sudrajat *et al.*, 2007). The possibility of chemical and natural catalyst modifications is also studied to optimize the transesterification reaction of Nyamplung oil (Dewajani *et al.*, 2016; Enggarwati and Ediati, 2013; Juwono *et al.*, 2013; Muhammad *et al.*, 2017; Qadariyah *et al.*, 2017).

Second, *Sasak* people use Nyamplung seed oil to heal and remove scars (Khery *et al.*, 2022). The oil in its seeds can treat skin pain and grow hair and other diseases. In Central Kalimantan, People are accustomed to using the yellow sap of anchor dragon rods (*C. inophyllum*) when they are attacked by scabs or itch. Meanwhile, the Dayak Suru community uses it as a dye (Emilda, 2019). In Chinese society, this plant is commonly used to treat eye pain, rheumatism, inflammation, and wounds (Kainuma *et al.*, 2016; Safrina and Murtini, 2021). Third, Nyamplung is planted or allowed to grow by Sasak communities on the banks of rivers and beaches. This is because they realize that with the Nyamplung plant, riverside erosion and coastal aberration can be prevented (Khery *et al.*, 2022). Nyamplung can be a soil-fattening agent to make the soil around it grow more fertile (Khamidah and Darmawan, 2018). Nyamplung plants can live in areas with high salinity and become a composition of mangrove ecosystem plants (Danu *et al.*, 2011).

The Nyamplung plant (*Calohyllum inophyllum* L.) includes members of the family Clusiaceae. The family consists of 20 genders with 1200 species. Calohyllum comes from the Greek words 'kalos' –beautiful and 'phullon'– leaf. It means beautiful leaves (Hegde and Warrier, 2015). In Indonesia *Calohyllum inophyllum* L is known as Camplung, Nyamplung, Bintanguru, Benaga, Bintangur Laut, Menaga, Naga, and Penaga Anchorkar. Nyamplung is a medium to large tree species. This plant has a wide distribution, ranging from Africa, India, Southeast Asia, Northern Australia, and others. It is found in almost all regions in Indonesia, especially coastal areas. Its habitat is 0 to 200 meters above sea level, with rainfall between 1,000-3,000 mm/year. Nyamplung grows in non-swampy habitats and sandy beaches. The tree is dark, leafy, between 10-30 m high. It generally grows rather bent or even parallel to the ground. Has a white or yellow sticky sap (Danu *et al.*, 2011; Emilda, 2019). Nyamplung plant characteristics are shown in **Fig. 1**.

The ethnoscience of Nyamplung has the potential to be developed into a science learning topic to improve student performance. Performance in science learning is the skill in observing, recording data and information, understanding the instructions, taking measurements, implementing procedures and using equipment, making predictions and inferences, selecting procedures, designing investigations, conducting investigations, and reporting on the results of investigations (Asy *et al.*, 2017; Khery *et al.*, 2013; Nufida *et al.*, 2020). Science learning includes learning science competencies, namely identifying scientific issues, explaining scientific phenomena, and using scientific evidence; learning science knowledge competencies, namely learning using content knowledge, using compiling knowledge, and using epistemological knowledge; learning the context of science, namely the application of science in everyday life; and learning the attitude of science, which is learning to show an attitude towards science which plays an important role in decision making (Rubini *et al.*, 2016). Topics exploring natural materials are perfect for project learning (Hakim and Jufri, 2018). Through investigating and exploring natural materials, project learning can improve process skills (Wildan *et al.*, 2019) and critical thinking (Hakim *et al.*, 2016).

Figure 1. Characteristics of Nyamplung **(a)** Trees, **(b)** Flowers, **(c)** Leaves, Fruits, **(d)** Seed Flesh and **(e)** Nyamplung Seed Oil (*Calophyllum inophyllum L.*).
Source: Elaborated by the authors.

Integrating science with local knowledge is crucial for preparing prospective science teachers, as it allows them to engage in authentic and open investigations of local knowledge. Hsu *et al.* (2009) suggest that when implemented authentically, scientific inquiry involves students in ways that closely mirror the practices of professional scientists. Bruck *et al.* (2008) support the practical application of open inquiry at both school and university levels. In open inquiry, learning occurs through investigation, with the instructor posing a question or problem and providing relevant background information. This approach is particularly suited for preparing future science teachers, emphasizing research skills essential for developing teaching materials and strategies. Employing open inquiry can enhance prospective science teachers' abilities to conduct independent investigations and scientifically validate local knowledge (Parmin *et al.*, 2022, 2016). However, many aspects of local knowledge in Indonesian society remain scientifically unverified, posing challenges to their integration into science education.

Engaging in open investigations to explore local knowledge can enhance creative thinking skills among prospective science teachers, enabling them to effectively design and implement such methods in their teaching activities (Hikmawati *et al.*, 2020; Sudarmin *et al.*, 2019). Chinn and Malhotra (2002) emphasize that open investigations are crucial for fostering the creative thinking employed by scientists. Lee *et al.* (2012) further support this, noting that student involvement and motivation in science learning are significantly improved through the application of open inquiry. Zion (2008) asserts that university-level learning activities should equip students with skills in sourcing scientific information, developing experimental techniques, and conducting independent scientific investigations. Instructors should guide students in formulating preliminary conclusions and structuring learning activities to closely resemble expert research practices. Sadeh and Zion (2012) identify the investigative component of open inquiry as the most complex, as it requires students to design their investigative processes.

However, development research that utilizes and explores the ethnoscience of Nyamplung plants in learning to improve students' scientific performance still needs to be carried out. Validation and design of teaching materials, as well as evaluation of the effectiveness and reliability of the application of learning to the performance of science, need to be evaluated. This article will describe aspects of science learning that can be obtained from Nyamplung ethnoscience. This article can be a recommendation for preparing teaching materials or worksheets for students towards Nyamplung ethnoscience-oriented learning, which aims to improve students' performance.

The lack of student engagement and declining performance in chemistry laboratories is a growing concern, particularly when traditional learning methods are used. Many students struggle to see the relevance of scientific concepts to their everyday lives, leading to disengagement and poor performance. Furthermore, conventional approaches often fail to incorporate cultural contexts that could enhance students' connection to the material. This study addresses these issues by integrating culturally relevant materials into chemistry education. Specifically, it explores the use of the Nyamplung plant, an element of the Sasak tribe's indigenous knowledge, in laboratory sessions. Ethnoscience offers an authentic way to engage students by linking scientific inquiry with local cultural practices, fostering deeper learning and motivation. This research aims to determine whether incorporating Nyamplung ethnoscience into laboratory activities can improve student engagement and performance. This research suggests that incorporating Nyamplung ethnoscience may enhance student performance and provide a meaningful connection between scientific theory and the cultural environment. This study contributes 1to science education and preserving indigenous knowledge, offering a practical model for improving student outcomes in culturally diverse contexts.

2. Methodology

This research employed a pre-experimental design with a pretest-posttest non-control group, as shown in **Fig. 2** (Cohen *et al.*, 2007; Sugiyono, 2010). This design was chosen because this study is a limited trial involving a small but sufficient subject to answer the research problem.

O1	X	O2

Figure 2. Scheme of pretest-posttest non-control group design.
Note: O1: Students initial laboratory performance; **X:** Nyamplung ethnoscience-oriented learning; **O2:** Students' laboratory performance after treatment.
Source: Adapted from Sugiyono (2010).

The study involved 17 students participating in the chemistry of natural product laboratory session, the study program of chemistry education, Mandalika University of Education, Mataram, Lombok Island, Indonesia. The research sample was taken in a saturated manner in purposive sampling by involving all the students participating in the natural products chemistry course as the subject of the study. The subject is divided into six groups of two or three students to facilitate observation during learning activities. The learning takes place from April to May 2023. The activities carried out consist of three themes as presented in **Table 1**.

Table 1. Laboratory activity's theme.

Laboratory session	Code	Theme
Initial session	P	Student performance in previous laboratory activities
Laboratory session 1	P1	Nyamplung seed extraction
Laboratory session 2	P2	Secondary metabolite screening of Nyamplung seed extract
Laboratory session 3	P3	Sunscreen activities evaluation of Nyamplung seed extract

Source: Elaborated by the authors.

Participants in an open laboratory inquiry environment are afforded considerable autonomy. Students can select and experiment with various extraction methods, phytochemical screening techniques, secondary metabolite analyses, and methods for evaluating sunlight-blocking activities.

Student laboratory performance during P1, P2, and P3 was assessed through performance observation and portfolio evaluations. Observation methods and portfolio assessments evaluate student performance. The things assessed are presented in **Table 2**. Performance assessment items are observed according to the science process skills Subali (2009) suggested. Each item was scored as 1 (achieved) or 0 (not achieved).

Learning activities during P1, P2, and P3 process consist of three major activities **Attempt direction (A)**, students exploring information (A1), defining problems (A2), and constructing hypothesis (A3); **Designing and executing projects (B)**, students create an observation plan (B1), collect observational data (B2), and drawing up conclusions (B3); **Discussion (C)**, students presenting products (C1); product excellence argumentation (C2); argue the environmental and social impact of products (C3). Initial laboratory performance (P) obtained from the assessment of previous laboratory session activities. The student used similar standards of reciprocal assessment to those of researchers on P1, P2, and P3. The data was collected by employing six observers who monitored each group of students during the laboratory sessions. Student performance was analyzed using percentage (**Eq. 1**), average (**Eq. 2**), and N-gain (**Eq. 3**) formulas as presented below (Cohen *et al.*, 2007).

$$P\% = \frac{score}{score\ max} \quad (1)$$

$$Average = \frac{Sum\ of\ all\ observations}{Total\ number\ of\ observation} \quad (2)$$

$$N-gain = \frac{postest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (3)$$

The score and N-gain are interpreted consecutively by category as presented in **Tables 3** and **4**.

Table 2. Students' performance assessment items.

Item observed	Activities assessed	
	Observation	Portfolio
Students gather information from a variety of sources		A1
Students make a summary		A1
Students set investigative / research variables		B1
Students raise the background of the importance of conducting investigation/research		A2
Students formulate investigation/research objectives		A2
Students make hypotheses		A3
Students select appropriate variables, collect relevant data, and select a form of presentation of results appropriate for a chosen investigative procedure		A3, B2
Students document pictures of observation objects		B2
Students present observations in a chart, graph, or histogram	C1	B2
Students compile and complete an investigative procedure		B1, B2
Students prepare units/measuring devices to take measurements	B2	
Students take measurements according to the measurement scale	B2	B2
Students use the appropriate measuring instruments correctly	B2	
Students make observations and collect data with measuring instruments	B2	
Students choose laboratory equipment that is following the task at hand	B2	
Students adopt laboratory procedures by minimizing risk		B1
Students move materials/materials/equipment using the right way/container	B2	
Students separate substances based on their form	B2	
Students do sample preparation	B1	
Students make/mix materials according to certain standards/concentrations	B2	
Students maintain work safety using glassware and hazardous chemicals	B2	
Students make observations and collect data using the five senses	B2	B2
Students convert units from a legible measure into another quantity		B2
Students recognize objects based on their characteristics	B2, B3	B2, B3
Students identify objects to match specific references/reading sources	B2, B3	B2, B3
Students identify similarities/differences between objects	B2, B3	B2, B3
Students match an object with a variety of visible characteristics	B2, B3	B2, B3
Students make reasonable generalizations/conclusions based on observations		B3
Students use observations to confirm or prove errors/refute existing hypotheses		B3
Students distinguish between observations and references/literature sources		B3, C1
Students generating ideas and conduct investigations related to everyday life		C3
Students formulate the benefits of investigation for the environment and society and promote innovation		A2, C2, C3
Students present observations in group discussions	C1, C2	C1, C2
Students demonstrate the excellence of their product/investigation results and pursue ideas to conduct new product	C1, C2, C3	C1, C2, C3

Source: Elaborated by the authors.

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Table 3. Students' performance category.

Score	Category
80—100	Excellence
60—79.99	Good
40—59.99	Poor
20—39.99	Fail

Source: Adapted from Arikunto (2016).

Table 4. N-gain category.

N-gain	Category
g>0.7	High
0.3≤g≤0.7	Medium
G<0.3	Low

Source: Adapted from Selis *et al.* (2023).

3. Results and discussion

3.1. Student performance in ethnoscience-oriented laboratory session learning Nyamplung

In the first session of learning implementation, students are invited to make direct observations about local knowledge in the village of Gunungsari, West Lombok district, West Nusa Tenggara province, Indonesia. The students observed and met directly with the local community to learn more about using Nyamplung. The student learned that the local community used the Nyamplung plant as a barrier to the erosion of rice paddy land around the river. In contrast, the flesh of the Nyamplung seeds was used to make dilah jojor (a kind of fire lamp) and used the seed oil as a disguise for scars on the skin. The student also got information about the local community who roasted the meat of the Nyamplung seeds and then pounded and squeezed mechanically to get the oil. This information is consistent with what has been presented by (Khery *et al.*, 2022). The results of the photos captured by students while exploring the activities of the Nyamplung cultivation community in Gunungsari village are presented in **Fig. 3**.

(a) (b)

Figure 3. **(a)** Nyamplung cultivation community; **(b)** collect old Nyamplung seeds in Gunungsari.
Source: Elaborated by the authors.

Laboratory activities carried out by all class participants departed from the fact that Nyamplung oil was used as a scar treatment. Many research results in the field of chemistry support this idea. Nyamplung (*Calophyllum inophyllum* L.) contains a lot of secondary metabolite compounds, mainly the group of Santon, coumarin, triterpenoid and flavonoid compounds. Based on several studies, the bioactivity exhibited by Nyamplung is quite diverse. The chemical compounds present in Nyamplung are varied, resulting in a wide range of bioactivities. Studies exploring this bioactivity have generally been conducted in vitro (Emilda, 2019). These include antioxidant, anticancer (Raju and Victoria, 2015), antiviral, anti-HIV, anti-inflammatory, antibacterial, antidiuretic, antidiabetic activities, and more (Artanti *et al.*, 2020; Hasibuan *et al.*, 2013; Kainuma *et al.*, 2016; Oo, 2021; Ragasa *et al.*, 2015). The results of the image capture by students related to the process they carried out in their laboratory activities are presented in **Fig. 4**.

(b) (c) (d)

Figure 4. Students use the extraction method. **(a)** sample preparation **(b)** alcohol maceration; **(c)** soxhletization of n-hexane; **(d)** mechanical press.
Source: Elaborated by the authors.

In implementing the first laboratory session, the extraction of Nyamplung oil, six groups of students were divided into 3 groups based on the methods used to adjust the state of laboratory facilities. The extraction methods are maceration techniques using alcohol, Soxhlet extraction using n-hexane solvents, and mechanical press methods. Samples of the flesh of the Nyamplung seeds are prepared by drying to reduce moisture content and ground to improve the contact surface. The image students captured during the Nyamplung extract phytochemical test is presented in **Fig. 5**.

(a) (b) (c)

Figure 5. Phytochemical test observation of Nyamplung oil sample **(a)** alcohol maceration extract; **(b)** soxhletization of n-hexane extract; **(c)** mechanical press extract.
Source: Elaborated by the authors.

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In the next laboratory session, students conducted a semi-qualitative phytochemical analysis to detect the presence of secondary metabolites in the alkaloids, flavonoids, terpenoids and steroids, tannins, and saponin tests. The student's methods are presented in Khery *et al.* (2023). The tests were carried out uniformly due to the limitations of laboratory facilities. Nevertheless, the students get different observation experiences. In the last laboratory session, students conducted SPF, erythema, and pigmentation tests in the sun protection activity test. The students were divided into three groups to test their respective samples. The first and second groups use Sayre *et al.* (1979; 2013). The first group executed the method by varying the type of solvent used when testing the sample. The second group executed the method by varying the sample concentration when testing it in an alcohol-chloroform solvent (1:1). The third group used the recommended method by Rejeki and Wahyuningsih (2015).

Figure 6 shows student performance in attempting direction activities, designing and executing projects, and discussing learning during the first, second, and third laboratory sessions.

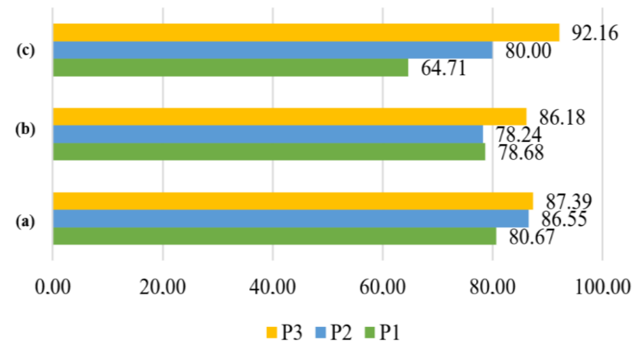

Figure 6. Student laboratory performance during **(a)** attempt direction, **(b)** designing and executing projects, and **(c)** discussion.
Source: Elaborated by the authors.

The results showed that, in general, students experienced improved performance in both attempt direction, designing and executing projects, and discussion activities. This can be caused by students getting used to the learning methods applied. The student also showed better attitudes during laboratory sessions. Ethnoscience-oriented learning does allow for increasing student interest, motivation, and learning outcomes in science learning (Fasasi, 2017b; Muliadi *et al.*, 2022; Munandar *et al.*, 2022). Increased interest and motivation will likely cause this increased performance (Lizzio *et al.*, 2002; Shakir, 2014).

A very sharp increase occurred in discussion activities. There are 64.71, 80.00, and 92.18 respectively. It enhances from good into the excellence category of performance. In this section, students present products, discuss product excellence, and argue about the environmental and social impact of products. Student performance has improved sharply, indicating that from the first laboratory session to the last, Students are increasingly confident in presenting the results of their experiments. Their orientation towards the resulting innovative product is getting better. An overview of product development ideas and how students affect the economic and social environment for the better can be presented in a better way. Discussion activities can positively influence students' motivation and critical thinking skills (Cholisoh *et al.*, 2015). Discussion activities motivated by investment and inquiry experiences result in better student motivation and perception of science learning (Gouvea *et al.*, 2022; Rahayu *et al.*, 2020).

The next interesting result of this study is the occurrence of a very small decrease in designing and executing projects during the first and second laboratory sessions. The average score in the good category is 78.68 and 78.24, respectively. This is due to the student's lack of ability to develop an investigation plan that allows for maximizing laboratory equipment or measuring instruments. The second laboratory session job is easier than the first. Previous research has shown that the more students engage in practical activities in the laboratory, the higher their motivation and learning performance in science learning (Ateş and Eryilmaz, 2011; Corter *et al.*, 2011; Sesen and Tarhan, 2013; Shana and Abulibdeh, 2020).

3.2. Improving student performance in ethnoscience-oriented laboratory session learning Nyamplung

Student performance in Nyamplung ethnoscience-oriented laboratory session learning is shown in **Fig. 7**.

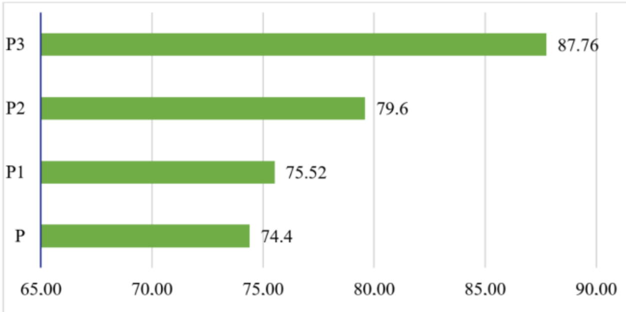

Figure 7. Student laboratory performance on the chemistry of natural product laboratory session with Nyamplung ethnoscience-oriented learning in P1, P2, and P3.
Source: Elaborated by the authors.

The results of this study show a gradual improvement in student performance throughout the Nyamplung ethnoscience-oriented laboratory sessions, with average scores increasing from 75.52 to 87.76. This demonstrates that implementing Nyamplung ethnoscience-oriented laboratory methods positively impacts student performance. The ethnoscience approach has enhanced students' attitudes toward science learning (Fitria and Widi, 2015; Muliadi *et al.*, 2022; Munandar *et al.*, 2022). These findings align with research by Zidny *et al.* (2020), which demonstrated that integrating indigenous knowledge into science education can increase student engagement and understanding of scientific processes. Pieter and Risamasu (2024) also reported that ethnoscientific learning materials enhance students' science process skills.

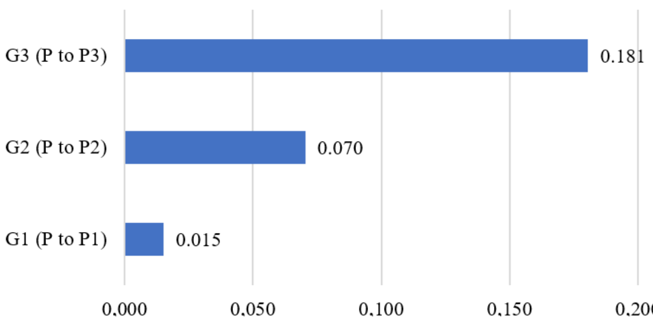

Figure 8. Student laboratory performance on the chemistry of natural product laboratory session with Nyamplung ethnoscience-oriented learning in P1, P2, P3.
Source: Elaborated by the authors.

Despite the overall improvement, the N-gain values remained in the low category, as shown in **Fig. 8** (0.015; 0.070; 0.181), indicating a moderate level of progress compared to studies like Hastuti *et al.* (2019), where medium N-gain scores were achieved. This suggests that while ethnoscience-based learning has positive effects, certain contextual or instructional factors may have limited the extent of improvement. These differences indicate that the ethnoscience approach offers clear benefits. Still, adjustments, such as extending the learning period or providing additional support, might be needed to enhance students' science process skills fully.

Previous research conducted by Ibe and Nwosu (2017) and Mudana (2023) emphasized the importance of active student involvement in ethnoscientific learning environments, which leads to significant gains in reasoning and inquiry skills. The findings of this study, particularly the improvement in discussion activities, support these conclusions, as students demonstrated a greater ability to articulate the scientific and societal relevance of their work. However, the lower gains in investigative skills, such as designing and executing projects, suggest challenges that may not have been as evident in previous research. These challenges could be due to the relatively short duration of the laboratory sessions or the novelty of the Nyamplung ethnoscience approach for students.

The application of Nyamplung ethnoscience-oriented learning improved student performance and supported the preservation of local knowledge and sustainable practices. Integrating indigenous knowledge into the curriculum helps preserve cultural heritage while promoting sustainability. For instance, students explored the potential of Nyamplung seed oil, traditionally used in the Sasak community, as a renewable energy source during the laboratory sessions. This connection between local knowledge and modern scientific inquiry enriches the curriculum and prepares students to address real-world problems. Zidny *et al.* (2020) argue that science education should aim to offer a balanced perspective by introducing students to diverse ways of understanding science. Incorporating indigenous knowledge broadens students' perspectives, enabling them to understand scientific concepts more holistically and recognize the influence of social and cultural contexts in shaping scientific knowledge (Zidny and Eilks, 2018; Zidny *et al.*, 2021).

This study provides insights into the potential for broader applications in science education. While it focused on the Nyamplung plant, the ethnoscience-based learning model can be adapted to other culturally significant plants or natural resources from various regions. Emphasizing the integration of local knowledge into science education allows this approach to be applied in different educational contexts, fostering a deeper understanding of science concerning students' cultural and environmental backgrounds. Elias *et al.* (2009) and Yazidi and Rijal (2024) advocate for educational reforms that integrate indigenous knowledge as a key element in science education, emphasizing its role in achieving sustainability goals by equipping students to tackle complex environmental and societal challenges.

The proposed teaching practice, which integrates Nyamplung ethnoscience into chemistry education, is believed to offer several benefits for student learning and the broader educational context. Integrating ethnoscience into learning can enhance student engagement and motivation. Using culturally relevant materials, such as the Nyamplung plant, allows students to connect their learning to their local environment and traditions. This relevance increases student interest and motivation, as demonstrated by the significant improvement in discussion activities, where students confidently presented their work and connected their findings to environmental and social impacts. Ethnoscience-oriented learning has been shown to improve motivation (Hariyono *et al.*, 2023; Munandar *et al.*, 2023), cognitive achievement (Fasasi, 2017a), and attitude toward science (Fasasi, 2017b). According to research by Hastuti *et al.* (2019) and Saija and Tahya (2023), ethnoscience-oriented learning effectively improves students' science process skills. Pieter and Risamasu (2024) also found that this approach enhances students' scientific skill development. Additionally, Ibe and Nwosu (2017) and Mudana (2023) recommend that education stakeholders, particularly teachers, actively engage students in the learning process by incorporating ethnoscientific strategies, as these methods have proven more effective for developing science process skills.

4. Conclusions

The main findings demonstrate a consistent improvement in student performance across three laboratory sessions, with average scores increasing from 75.52 in the first laboratory session to 87.76 in the third. Although the N-gain values indicated a low level of improvement (0.015, 0.070, and 0.181), the upward trend suggests that ethnoscience-based learning positively impacts student engagement, motivation, and skill development in the laboratory environment. The most significant gains were observed in discussion activities, where students exhibited increased confidence and ability to articulate their experiments' environmental and social relevance. This study contributes to the growing body of literature on ethnoscience and its application in science education, particularly in the context of chemistry learning. By incorporating local knowledge, such as using Nyamplung seed oil, the study demonstrates how culturally relevant materials can enhance the learning experience and improve student outcomes in scientific disciplines. The study emphasizes the potential of Indigenous science to enrich science education and recommends further research in broader educational settings.

Recommendations: Teachers should consider integrating ethnoscience-based teaching materials into their curricula to foster deeper student engagement and enhance practical laboratory skills. Specifically, utilizing local knowledge not only makes science more relevant and accessible to students but also promotes the preservation of cultural heritage. To maximize the effectiveness of this approach, teachers should provide opportunities for open inquiry, allowing students to explore and apply local knowledge in scientific contexts. Future studies should consider implementing this model in larger student populations and across various cultural settings to further validate its effectiveness and broaden its application.

Limitations: Several limitations of this study should be acknowledged. **Small sample size:** The study involved only 17 students, which limits the generalizability of the results to a broader student population. While the findings are promising, a larger sample would provide more robust evidence of the effectiveness of ethnoscience-oriented learning. **Lack of control group:** As mentioned, the study did not include a control group that followed a traditional laboratory approach without ethnoscience content. This limits the ability to determine whether the observed improvements in performance were directly due to the ethnoscience-based methods or other factors, such as increased familiarity with laboratory work overtime. **Short duration:** The study was conducted over a relatively short period, with three consecutive laboratory sessions. While the results show improvement, a longer-term study would provide more insight into the sustainability of these gains and whether the student persists beyond the initial learning phase. **Cultural specificity:** The ethnoscience approach is closely tied to the cultural knowledge of the Sasak tribe. While this is a strength in promoting local knowledge, it also limits the transferability of the approach to other regions with different ethnoscience traditions. A more diverse exploration of ethnoscience from multiple cultures could provide a broader application of this teaching method.

Authors' contribution

Conceptualization: Aliefman Hakim; Yusran Khery; **Data curation**: Yusran Khery; **Formal Analysis**: Yusran Khery; Aliefman Hakim; Aa Sukarso; **Funding acquisition**: Alieman Hakim; **Investigation**: Yusran Khery; **Methodology**: Yusran Khery; Joni Rokhmat; **Project administration**: Yusran Khery; **Resources**: Not applicable; **Software**: Not Applicable; **Supervision**: Aliefman Hakim; **Validation**: Joni Rokhmat; Aa Sukarso; **Visualization**: Yusran Khery; **Writing – original draft**: Yusran Khery; **Writing – review & editing**: Yusran Khery; Aliefman Hakim.

Data availability statement

All data sets were generated or analyzed in the current study.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

Ansori, A.; Wibowo, S. A.; Kusuma, H. S.; Bhuana, D. S.; Mahfud, M. Production of Biodiesel from Nyamplung (Calophyllum Inophyllum L.) Using Microwave with CaO Catalyst from Eggshell Waste: Optimization of Transesterification Process Parameters. *Open Chem.* **2019**, *17* (1), 1185–1197. https://doi.org/10.1515/chem-2019-0128

Arikunto, S. *Prosedur Penelitian (Suatu Pendekatan Praktik)*; Rieneka Cipta: Jakarta, 2016.

Artanti, A. N.; Rahmawati, K. N.; Rakhmawati, R.; Prihapsara, F. Uji Aktivitas Antibakteri Dan Antijamur Dari Kombinasi Minyak Nyamplung (*Calophyllum Inophyllum* L.) Dengan Virgin Coconut Oil Dan Pengembangannya Sebagai Face. *J. Farm. Indones.* **2020**, *17* (2), 17–29.

Asy, M.; Fitriani, H.; Pendidikan, P.; Mataram, F. I. Literatur Reviu Keterampilan Proses Sains Sebagai Dasar Pengembangan Keterampilan Berpikir Tingkat Tinggi Keterampilan Proses Sains Sebagai Dasar Pengembangan Keterampilan Berpikir Tingkat. **2017**, *5* (1), 1–7.

Ateş, Ö.; Eryilmaz, A. Effectiveness of Hands-on and Minds-on Activities on Students' Achievement and Attitudes towards Physics. *Asia-Pacific Forum Sci. Learn. Teach.* **2011**, *12* (1), 1–22.

Bruck, L. B.; Bretz, S. L.; Towns, M. H. Characterizing the Level of Inquiry in the Undergraduate Laboratory. *J. Coll. Sci. Teach.* **2008**, *38* (1), 52–58.

Chasani, M.; Senny Widyaningsih; Adidyan Mubarok Synthesis and Characterization of Sodium Soap From. *Molekul*. **2015**, *10* (1), 66–73.

Chinn, C. A.; Malhotra, B. A. Epistemologically Authentic Inquiry in Schools: A Theoretical Framework for Evaluating Inquiry Tasks. *Sci. Educ.* **2002**, *86* (2), 175–218. https://doi.org/10.1002/sce.10001

Cholisoh, L.; Fatimah, S.; Yuniasih, F. Critical Thinking Skills in Integrated Science Learning Viewed from Learning Motivation. **2015**, *11* (2), 134–141. https://doi.org/10.15294/jpfi.v11i2.4241

Cohen, L.; Manion, L.; Lecturer, P.; Morrison, K.; Lecturer, S. *Research Methods in Education*; 2007.

Corter, J. E.; Esche, S. K.; Chassapis, C.; Ma, J.; Nickerson, J. V. Process and Learning Outcomes from Remotely-Operated, Simulated, and Hands-on Student Laboratories. *Comput. Educ.* **2011**, *57* (3), 2054–2067. https://doi.org/10.1016/j.compedu.2011.04.009

Danu, D.; Subiakto, A.; Abidin, A. Z. Pengaruh Umur Pohon Induk Terhadap Perakaran Stek Nyamplung (Calophyllum Inophyllum L.). *J. Penelit. Hutan Tanam.* **2011**, *8* (1), 41–49. https://doi.org/10.20886/jpht.2011.8.1.41-49

Dewajani, H.; Rochmadi; Purwono, S.; Budiman, A. Effect of Modification ZSM-5 Catalyst in Upgrading Quality of Organic Liquid Product Derived from Catalytic Cracking of Indonesian Nyamplung Oil (Calophyllum Inophyllum). *AIP Conf. Proc.* **2016**, *1755* (2016), 1–7. https://doi.org/10.1063/1.4958485

Dewi, C. A.; Khery, Y.; Erna, M. An Ethnoscience Study in Chemistry Learning to Develop Scientific Literacy. *J. Pendidik. IPA Indones.* **2019**, *8* (2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Elias, D.; Tran, P.; Nakashima, D.; Shaw, R. Indigenous Knowledge, Science and Education for Sustainable Development. *Indig. Knowl. Disaster Risk Reduct. From Pract. to Policy*. **2009**, No. October, 87–102.

Emilda, E. Tumbuhan Nyamplung (Calohyllum Inophyllum Linn) Dan Bioaktifitasnya. *Simbiosa*. **2019**, *8* (2), 136–147. https://doi.org/10.33373/sim-bio.v8i2.2000

Enggarwati, E. R.; Ediati, R. Pemanfaatan Kulit Telur Ayam Dan Abu Layang Batubara Sebagai Katalis Heterogen Untuk Reaksi Transesterifikasi Minyak Nyamplung (Calophyllum Inophyllum Linn). *J. Sains dan Seni Pomits*. **2013**, *2* (1), 1–6.

Fadhlullah, M.; Widiyanto, S. N. B.; Restiawaty, E. The Potential of Nyamplung (Calophyllum Inophyllum L.) Seed Oil as Biodiesel Feedstock: Effect of Seed Moisture Content and Particle Size on Oil Yield. In *Energy Procedia*; Elsevier, 2015; Vol. 68, pp 177–185. https://doi.org/10.1016/j.egypro.2015.03.246

Fasasi, R. A. The Impact of Ethnoscience Instruction on Cognitive Achievement in Science. *Int. J. Educ. Learn.* **2017a**, *6* (2), 33–42. https://doi.org/10.14257/ijel.2017.6.2.03

Fasasi, R. A. Effects of Ethnoscience Instruction, School Location, and Parental Educational Status on Learners' Attitude towards Science. *Int. J. Sci. Educ.* **2017b**, *39* (5), 548–564. https://doi.org/10.1080/09500693.2017.1296599

Fitria, M.; Widi, A. The Development of Ethnoscience-Based Chemical Enrichment Book as a Science Literacy Source of Students. *Int. J. Chem. Educ. Res.* **2015**, *2* (1), 50–57.

Gouvea, J.; Appleby, L.; Fu, L.; Wagh, A. Motivating and Shaping Scientific Argumentation in Lab Reports. *CBE Life Sci. Educ.* **2022**, *21* (4). https://doi.org/10.1187/cbe.21-11-0316

Hakim, A.; Jufri, A. W. Natural Products Laboratory Project: Isolation and Structure Elucidation of Piperin from Piper Nigrum and Andrographolide from Andrographis Paniculata. *J. Turkish Sci. Educ.* **2018**, *15* (4), 15–28. https://doi.org/10.12973/tused.10243a

Hakim, A.; Liliasari; Kadarohman, A.; Syah, Y. M. Improvement of Student Critical Thinking Skills with the Natural Product Mini Project Laboratory Learning. *Indones. J. Chem.* **2016**, *16* (3), 322–328. https://doi.org/10.22146/ijc.21149

Handayani, P. A.; Abdullah, A.; Hadiyanto, H. Biodiesel Production from Nyamplung (Calophyllum Inophyllum) Oil Using Ionic Liquid as a Catalyst and Microwave Heating System. *Bull. Chem. React. Eng. & Catal.* **2017**, *12* (2), 293–298. https://doi.org/10.9767/bcrec.12.2.807.293-298

Hariyono, E.; Rizki, I. A.; Lestari, D. A.; Citra, N. F.; Islamiyah, A. N.; Agusty, A. I. Engklek Game Ethnoscience-Based Learning Material (Egeblm) To Improve Students' Conceptual Understanding and Learning Motivation. *J. Pendidik. IPA Indones.* **2023**, *12* (4), 635–647. https://doi.org/10.15294/jpii.v12i4.43941

Hasibuan, S.; Sahirman; Yudawati, N. M. A. Karakteristik Fisiokimia Dan Antibakteria Hasil Purifikasi Minyak Biji Nyamplung (*Calophyllum Inophyllum* L.). *Agritech*. **2013**, *33* (3), 311–319. https://doi.org/http://dx.doi.org/10.22146/agritech.9553

Hastuti, P. W.; Setianingsih, W.; Widodo, E. Integrating Inquiry Based Learning and Ethnoscience to Enhance Students' Scientific Skills and Science Literacy. *J. Phys. Conf. Ser.* **2019**, *1387* (1). https://doi.org/10.1088/1742-6596/1387/1/012059

Hayadi. Maleman "Tradisi Menghidupkan Malam Laylatul Qadar" Di Desa Bilok Petung. *J. Al-Irfani Stud. Al-Qur'an dan Tafsir*. **2021**, *2* (1), 40–49. https://doi.org/doi.org/10.51700/irfani.v2i01.231

Hegde, M.; Warrier, K. C. *Manual of Economically Important Forestry Species in South India*; Institute of Forest Genetics and Tree Breeding (Indian COuncil of Forestry Research and Education): Coimbatore, Tamil Nadu, India, 2015.

Hikmawati; Suastra, I.; Pujani, N. Local Wisdom in Lombok Island with The Potential of Ethnoscience for the Development of Learning Models in Junior High School. In *The 10th International Conference on Theoretical and Applied Physics (ICTAP2020)*; 2020; pp 1–12. https://doi.org/10.1088/1742-6596/1816/1/012105

Hsu, P. L.; Roth, W. M.; Mazumder, A. Natural Pedagogical Conversations in High School Students' Internship. *J. Res. Sci. Teach.* **2009**, *46* (5), 481–505. https://doi.org/10.1002/tea.20275

Ibe, E.; Nwosu, A. A. Effects of Ethnoscience and Traditional Laboratory Practical on Science Process Skills Acquisition of Secondary School Biology Students in Nigeria. *Br. J. Multidiscip. Adv. Stud.* **2017**, *1* (1), 10–21.

Juwono, H.; Triyono; Sutarno; Wahyuni, E. T. The Influence of Pd Impregnation into Al-MCM-41 on the Characters and Activity for Biogasoline Production by Catalytic Hydrocracking of Fames from Nyamplung Seed Oil (Calophyllum Inophyllum). *Indones. J. Chem.* **2013**, *13* (2), 171–175. https://doi.org/10.22146/ijc.21301

Kainuma, M.; Baba, S.; Chan, H. T.; Inoue, T.; Tangah, J.; Chan, W. C. Medicinal Plants of Sandy Shores : A Short Review on Calophyllum Inophyllum and Thespesia Populnea. *Int. J. Pharmacogn. Phytochem. Res.* **2016**, *8* (12), 2056–2062.

Khamidah, N.; Darmawan, A. R. B. Viabilitas Benih Nyamplung (CalophylluminophylummL) Dari Biji Yang Telah Di Skarifikasi Terhadap Media Tanam Yang Berbeda. *Ziraa'ah*. **2018**, *43* (1), 104–110.

Khery, Y.; Hakim, A.; Rokhmat, J.; Sukarso, A. Aktivitas Tabir Surya Ekstrak Biji Nyamplung (Calophyllum Inophyllum Linn). *Biosci. J. Ilm. Biol.* **2023**, *11* (1), 769. https://doi.org/10.33394/bioscientist.v11i1.7972

Khery, Y.; Sarjan, M.; Nufida, B. A.; Efendi, I. Etnosains Tumbuhan Nyamplung (Calophyllum Inophillum L.) Dalam Tradisi Masyarakat Sasak. *Biocaster J. Kaji. Biol.* **2022**, *2* (4), 176–188.

Khery, Y.; Subandi, S.; Ibnu, S. Metakognitif, Proses Sains, Dan Kemampuan Kognitif Mahasiswa Divergen Dan Konvergen Dalam PBL. *Prism. Sains J. Pengkaj. Ilmu dan Pembelajaran Mat. dan IPA IKIP Mataram*. **2013**, *1* (1), 37. https://doi.org/10.33394/j-ps.v1i1.517

Kurniati, S.; Soeparman, S.; Yuwono, S. S.; Hakim, L. Characteristics and Potential of Nyamplung (*Calophyllum Inophyllum* L.) Seed Oil from Kebumen, Central Java, as a Biodiesel Feedstock. *Int. Res. J. Adv. Eng. Sci.* **2018**, *3* (4), 148–152.

Kusniati, M. Pendidikan Karakter Melalui Pembelajaran IPA. *J. Pendidik. IPA Indones.* **2012**, *1* (2), 204–210. https://doi.org/https://doi.org/10.15294/jpii.v1i2.2140

Lee, H.; Yen, C. F.; Aikenhead, G. S. Indigenous Elementary Students' Science Instruction in Taiwan: Indigenous Knowledge and Western Science. *Res. Sci. Educ.* **2012**, *42* (6), 1183–1199. https://doi.org/10.1007/s11165-011-9240-7

Lizzio, A.; Wilson, K.; Simons, R. University Students' Perceptions of the Learning Environment and Academic Outcomes: Implications for Theory and Practice. *Stud. High. Educ.* **2002**, *27* (1), 27–52. https://doi.org/10.1080/03075070120099359

Mashami, R. A.; Suryati, S.; Harisanti, B. M.; Khery, Y. Identification of Local Wisdom of The Sasak Tribe In Chemistry Learning as an Effort to Strengthen Student Character. *J. Penelit. Pendidik. IPA*. **2023**, *9* (1), 337–345. https://doi.org/10.29303/jppipa.v9i1.2434

Ministry of Education and Cultrue *Kurikulum 2013*; Kementrian Pendidikan dan Kebudayaan: Jakarta, 2012.

Mudana, W. The Effect of Ethnoscience-Based Course Review Horay Learning towards Cultural Concept Understanding and Science Process Skills of the Elementary School Students. *Nurture*. **2023**, *17* (2), 137–148. https://doi.org/10.55951/nurture.v17i2.253

Muhammad, F. R.; Jatranti, S.; Qadariyah, L.; Mahfud Pembuatan Biodiesel Dari Minyak Biji Nyamplung Menggunakan Pemanasan Gelombang Mikro. *J. Tek. POMITS*. **2017**, *3* (1), 50–55.

Muliadi, A.; Wazni, M. K.; Yamin, M.; Khery, Y. Ethnoscience Studies in Songket Sasak Cloth Motifs: Prospective Science Teacher Perceptions. **2022**, *8* (6), 2613–2620. https://doi.org/10.29303/jppipa.v8i6.2414

Munandar, R.; Apsari, P. A. D.; Diarta, M. H.; Nurhasanah; Arni, K. J.; Rahmat, S.; Walihah, Z.; Hikmawati The Effect of the Contextual Teaching and Learning (Ctl) Learning Model Based on Simulation Media on the Motivation and Learning Outcomes of Students in Physics Learning. *J. Teach. Learn. Phys.* **2022**, *7* (2), 88–96. https://doi.org/10.15575/jotalp.v7i2.17116

Munandar, R.; Apsari, P. A. D.; Diarta, M. H.; Nurhasanah, N.; Arni, K. J.; Rahmat, S.; Walihah, Z.; Hikmawati, H. The Effect of Ethnoscience-Based CTL (Contextual Teaching and Learning) Model on Motivation and Physics Learning Outcomes of Students on the Topic of Sound Waves. *J. Sci. Educ.* **2023**, *4* (1), 16–23. https://doi.org/10.29303/jossed.v4i1.1864

Musta, R.; Haetami, A.; Salmawati, M. Biodiesel of The Transesterification Product of Calophyllum Inophyllum Seed Oil From Kendari Using Methanol Solution. *Ind. J. Chem. Res.* **2017**, *4* (2), 394–401.

Nufida, B. A.; Khery, Y.; Rahayu, S.; Budiasih, E. Correlation amongst Understanding of NOS, Conceptual Understanding, and Science Process Skill of Undergraduate Students on General Chemistry Correlation Amongst Understanding of NOS, Conceptual Understanding, and Science Process Skill of Undergraduate. **2020**, *030024*.

Okechukwu, S. A.; Lawrence, A.; Njoku, M. I. A. Innovations in Science and Technology Education: A Case for Ethnoscience Based Science Classrooms. *Int. J. Sci. Eng. Res.* **2014**, *5* (1), 52–56.

Oo, W. M. Pharmacological Properties of Calophyllum Inophyllum – Updated Review Pharmacological. *Int. J. Photochem. Photobiol.* **2021**, *2* (1), 28–32. https://doi.org/10.11648/j.ijpp.20180201.16

Parmin, P.; Noor, E.; Khusniati, M.; Zaky, R. A.; Islami, E. The Prospective Science Teachers' Skills in Reconstructing Indigenous Knowledge of Local Culture on Breast Milk Using Pare (Momordica Charantia). *Int. J. Educ. Res. Open*. **2022**, *3* (July). https://doi.org/https://doi.org/10.1016/j.ijedro.2022.100193

Parmin; Sajidan; Ashadi; Sutikno; Maretta, Y. Preparing Prospective Teachers in Integrating Science and Local Wisdom through Practicing Open Inquiry. *J. Turkish Sci. Educ.* **2016**, *13* (2), 3–14. https://doi.org/10.12973/tused.10163a

Pieter, J.; Risamasu, P. V. M. Integrating Ethnoscience in Physics Teaching Materials and Its Impact on Student's Science Process Skills and Mastery Concept. *J. Penelit. Pendidik. IPA*. **2024**, *10* (6), 2948–2955. https://doi.org/10.29303/jppipa.v10i6.7210

Qadariyah, L.; Syahir, S. N.; Fyadlon, A.; Bhuana, D. S.; Mahfud, M. Optimization of In-Situ Transesterification Process of Biodiesel from Nyamplung (Calophyllum Inophyllum L.) Seed Using Microwave. *Rasayan J. Chem.* **2017**, *10* (3), 952–958. https://doi.org/10.7324/RJC.2017.1031803

Ragasa, C. Y.; Jr, V. E.; Reyes, M. M. D. L.; Emelina, H.; Brkljača, R.; Urban, S. Triterpenes from Calophyllum Inophyllum Linn. *Int. J. Pharmacogn. Phytochem. Res.* **2015**, *7* (4), 718–722.

Rahayu, S.; Bambut, K. E. N.; Fajaroh, F. Do Different Discussion Activities in Developing Scientific Argumentation Affect Students' Motivation in Chemistry? *Cakrawala Pendidik.* **2020**, *39* (3), 679–693. https://doi.org/10.21831/cp.v39i3.32228

Raju, D. C.; Victoria, T. D. Phytochemical Screening and Bioactivity Studies of Immature and Mature Leaves of Calophyllum Inophyllum L. *J. Chem. Pharm. Sci.* **2015**, *8* (1), 46–51.

Rejeki, S.; Wahyuningsih, S. S. Formulasi Gel Tabir Surya Minyak Nyamplung (Tamanu Oil) Dan Uji Nilai SPF Secara In Vitro. In *University Research Colloquium 2015*; 2015; pp 97–103.

Rist, S.; Dahdouh-Guebas, F. Ethnosciences - A Step towards the Integration of Scientific and Indigenous Forms of Knowledge in the Management of Natural Resources for the Future. *Environ. Dev. Sustain.* **2006**, *8* (4), 467–493. https://doi.org/10.1007/s10668-006-9050-7

Rubini, B.; Ardianto, D.; Pursitasari, I. D.; Permana, I. Identify Scientific Literacy from The Science Teachers Perspective. *J. Pendidik. IPA Indones.* **2016**, *5* (2), 299–303. https://doi.org/10.15294/jpii.v5i2.7689

Sadeh, I.; Zion, M. Which Type of Inquiry Project Do High School Biology Students Prefer: Open or Guided? *Res. Sci. Educ.* **2012**, *42* (5), 831–848. https://doi.org/10.1007/s11165-011-9222-9

Safrina, U.; Murtini, G. Phytochemical Screening and Antioxidant Activity of Nyamplung Seed Oils (C*alophyllum Inophyllum* L.). *Sanitas J. Teknol. dan Seni Kesehat.* **2021**, *11* (2), 256–268. https://doi.org/https://doi.org/10.36525/sanitas.2020.24 ABSTRACT

Saija, M.; Tahya, D. Can the Ethnoscience-Based Inquiry Learning Model Improve Students' Science Process Skills? *Molluca J. Chem. Educ.* **2023**, *13* (1), 40–46. https://doi.org/10.30598/mjocevol13iss1pp40-46

Sayre, R. M.; Marlowe, E.; Agin, P.; LeVee, G.; Rosenberg, E. Performance of Six Sunscreen Formulations on Human Skin: A Comparison. *Arch Dermatol*. **1979**, *115* (1), 46–49. https://doi.org/10.1001/archderm.1979.04010010018006

Sayre, R. M.; Dowdy, J. C.; Rosenberg, E. W. Sun-Protection Factor Confounded by Anti-Inflammatory Activity of Sunscreen Agents? *J. Am. Acad. Dermatol.* **2013**, *69* (3), 481. https://doi.org/10.1016/j.jaad.2013.01.047

Selis, S.; Artamevia, T.; Ramdani, T.; Efendi, V. A.; Nugraha, Y. T.; Rahayu, E. T. The Effectiveness of Project Based Learning in the Merdeka Curriculum on the Basic Technical Skills of Basketball for Junior High School Students. *J. Pendidik. dan Konseling*. **2023**, *5* (1), 1118–1122.

Sesen, B. A.; Tarhan, L. Inquiry-Based Laboratory Activities in Electrochemistry: High School Students' Achievements and Attitudes. *Res. Sci. Educ.* **2013**, *43* (1), 413–435. https://doi.org/10.1007/s11165-011-9275-9

Shakir, M. Academic Anxiety as a Correlate of Academic Achievement. *J. Educ. Pract.* **2014**, *5* (10), 29–37.

Shana, Z.; Abulibdeh, E. S. Science Practical Work and Its Impact on Students' Science Achievement. *J. Technol. Sci. Educ.* **2020**, *10* (2), 199–215. https://doi.org/10.3926/JOTSE.888

Subali, B. Pengembangan Tes Pengukuran Keterampilan Proses Sains Pola DIvergen Mata Pelajaran Biologi SMA. In *Prosiding Seminar Nasional Biologi, Lingkungan, dan Pembelajarannya*; 2009; pp 581–593.

Sudarmin, S.; Sumarni, W.; Endang, P. R. S.; Susilogati, S. S. Implementing the Model of Project-Based Learning: Integrated with ETHNO-STEM to Develop Students' Entrepreneurial Characters. In *IOP Conf. Series: Journal of Physics: ICOMSET 2018*; IOP Publishing, 2019; pp 1–8. https://doi.org/10.1088/1742-6596/1317/1/012145

Sudrajat, R.; Sahirman, S.; Setiawan, D. Pembuatan Biodiesel Dari Biji Nyamplung. *J. Penelit. Has. Hutan*. **2007**, *25* (1), 41–56. https://doi.org/10.20886/jphh.2007.25.1.41-56

Sugiyono *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D*; CV Alfabeta: Bandung, 2010.

Tauro, A.; Ojeda, J.; Caviness, T.; Moses, K. P.; Moreno-Terrazas, R.; Wright, T.; Zhu, D.; Poole, A. K.; Massardo, F.; Rozzi, R. Field Environmental Philosophy: A Biocultural Ethic Approach to Education and Ecotourism for Sustainability. *Sustain.* **2021**, *13* (8), 1–22. https://doi.org/10.3390/su13084526

Wildan, W.; Hakim, A.; Siahaan, J.; Anwar, Y. A. S. A Stepwise Inquiry Approach to Improving Communication Skills and Scientific Attitudes on a Biochemistry Course. *Int. J. Instr.* **2019**, *12* (4), 407–422. https://doi.org/10.29333/iji.2019.12427a

Yazidi, R. El; Rijal, K. Science Learning in the Context of "Indigenous Knowledge" for Sustainable Development. *Int. J. Ethnoscience Technol. Educ.* **2024**, *1* (1), 28. https://doi.org/10.33394/ijete.v1i1.10880

Zidny, R.; Eilks, I. Indigenous Knowledge as a Socio-Cultural Context of Science to Promote Transformative Education for Sustainable Development: Insights into a Case Study on the Baduy Community (Indonesia). *Build. Bridg. across Discip. Transform. Educ. a Sustain. Futur.* **2018**, No. October, 249–256.

Zidny, R.; Sjöström, J.; Eilks, I. A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability. *Sci. Educ.* **2020**, *29* (1), 145–185. https://doi.org/10.1007/s11191-019-00100-x

Zidny, R.; Solfarina, S.; Aisyah, R. S. S.; Eilks, I. Exploring Indigenous Science to Identify Contents and Contexts for Science Learning in Order to Promote Education for Sustainable Development. *Educ. Sci.* **2021**, *11* (3). https://doi.org/10.3390/educsci11030114

Zion, M. On Line Forums as a "rescue Net" in an Open Inquiry Process. *Int. J. Sci. Math. Educ.* **2008**, *6* (2), 351–375. https://doi.org/10.1007/s10763-006-9051-x