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Integration of Ethnoscience into E-STEM Learning in Madrasah Ibtidaiyah

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ABSTRACT. This study explores the integration of ethnoscience into Environmental-Science, Technology, Engineering, and Mathematics (E-STEM) learning in a Madrasah Ibtidaiyah in Deli Serdang Regency, Indonesia. Employing a qualitative single-case study design, data were collected through classroom observations, semi-structured interviews with the principal, curriculum coordinator, teachers, and students, and document analysis. The data were analyzed using the interactive model of Miles, Huberman, and Saldaña. The findings reveal that local wisdom was effectively integrated into E-STEM learning by utilizing community knowledge, local environmental resources, traditional agricultural practices, and medicinal plants as contextual learning materials. Learning was implemented through inquiry-based and project-based activities that actively engaged students in investigating real-life environmental issues. The integration of ethnoscience enhanced students' conceptual understanding of science by connecting scientific knowledge with familiar cultural contexts while fostering environmental awareness and Islamic values of stewardship and responsibility. The study concludes that ethnoscience-based E-STEM learning provides a meaningful and culturally responsive instructional model for strengthening science education in Madrasah Ibtidaiyah.

Keywords: *Ethnoscience; E-STEM Learning; Local Wisdom; Madrasah Ibtidaiyah; Science Education.*

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INTRODUCTION

Education in the twenty-first century demands learning approaches that not only develop students' conceptual understanding but also equip them with critical thinking, creativity, collaboration, and problem-solving skills. In response to these demands, STEM (Science, Technology, Engineering, and Mathematics) education has become one of the most widely adopted pedagogical frameworks because it integrates interdisciplinary knowledge with authentic problem-solving experiences(Halawa et al., 2024). More recently, the concept has evolved into Environmental-STEM (E-STEM), which incorporates environmental sustainability into STEM learning, enabling students to understand scientific concepts while developing environmental awareness and responsible citizenship(Artika & Rosemary, 2023). This approach aligns with the Sustainable Development Goals (SDGs), particularly Goal 4 concerning quality education and Goal 13 regarding climate action, by encouraging contextual and meaningful learning experiences that connect classroom knowledge with real-life environmental issues.

Although E-STEM has demonstrated considerable potential for improving scientific literacy and higher-order thinking skills, its implementation in elementary education often remains disconnected from students' socio-cultural backgrounds. Learning activities frequently emphasize abstract scientific concepts without considering the local knowledge systems that students encounter in their daily lives(Matindike & Ramdhany, 2025). Consequently, science learning becomes less meaningful and fails to foster students' appreciation of their own cultural heritage. Integrating ethnoscience into E-STEM offers an effective solution by bridging scientific concepts with indigenous knowledge, local traditions, and community practices(Ogegbo & Ramnarain, 2024). Ethnoscience recognizes that scientific principles are embedded within local wisdom developed through generations, making learning more contextual, relevant, and culturally responsive.

Ethnoscience has gained increasing attention in Indonesian educational research because it promotes meaningful science learning while preserving cultural identity. Previous studies indicate that ethnoscience-based instruction enhances students' scientific literacy, conceptual understanding, creativity, and environmental awareness by connecting modern scientific knowledge with local cultural practices(Department of Science Education, Universitas Negeri Semarang, Central Java, Indonesia et al., 2024). In Madrasah Ibtidaiyah, ethnoscience also supports the integration of Islamic educational values, encouraging students to appreciate nature as Allah's creation while fostering responsibility for environmental conservation. Therefore, ethnoscience not only enriches cognitive learning but also contributes to the development of students' character and spiritual awareness through contextual educational experiences.

Deli Serdang Regency, North Sumatra, possesses abundant cultural and environmental resources that provide valuable contexts for ethnoscience-based learning. The region is characterized by diverse ethnic communities, including Malay, Karo, Javanese, and Mandailing, whose traditional knowledge is reflected in agricultural practices, medicinal plants, local foods, handicrafts, water management systems, and environmental conservation traditions. These forms of local wisdom represent authentic learning resources that can be integrated into E-STEM instruction to help students understand scientific concepts through familiar cultural contexts(Rosyidah et al., 2025a). By utilizing local wisdom as learning content, teachers can create instructional activities that are more engaging, inquiry-based, and relevant to students' everyday experiences while simultaneously preserving local cultural heritage.

Despite its considerable potential, the integration of ethnoscience into E-STEM learning in Madrasah Ibtidaiyah remains limited. Many teachers continue to rely on textbooks and conventional instructional approaches that rarely incorporate local cultural knowledge into science learning. Challenges include limited teacher understanding of ethnoscience concepts, insufficient instructional materials, inadequate professional development, and difficulties in designing interdisciplinary E-STEM activities based on local wisdom. In addition, the absence of structured teaching modules and contextual learning resources often discourages teachers from implementing innovative instructional practices(De Putter - Smits et al., 2022). These constraints reduce opportunities for students to experience science learning that is simultaneously meaningful, culturally relevant, and environmentally oriented.

Several recent studies have reported positive outcomes from integrating ethnoscience with STEM-oriented learning. Students who participate in ethnoscience-based instruction demonstrate improved scientific literacy, collaboration, creativity, critical thinking, and environmental responsibility(Citra Ayu Dewi et al., 2021). Furthermore, contextual learning based on local wisdom enhances students' motivation because scientific concepts are directly connected to phenomena they observe within their communities. Such findings suggest that ethnoscience provides a strong pedagogical foundation for strengthening E-STEM implementation in elementary education while simultaneously preserving local cultural identity and promoting sustainable development(Asmayawati et al., 2024).

However, previous studies have primarily focused on general elementary schools or secondary education, whereas research examining the integration of ethnoscience into E-STEM learning in Madrasah Ibtidaiyah, particularly within the socio-cultural context of Deli Serdang Regency, remains relatively limited. Moreover, few studies have explored how local wisdom can be systematically transformed into E-STEM learning resources while simultaneously integrating Islamic educational values. Addressing this gap is important because Madrasah Ibtidaiyah serves not only as an institution for academic development but also for cultivating students' religious character, environmental ethics, and cultural identity.

Therefore, this study aims to analyze the integration of ethnoscience into E-STEM learning in Madrasah Ibtidaiyah in Deli Serdang Regency. Specifically, it investigates how local wisdom can be transformed into contextual learning resources, explores teachers' strategies for implementing ethnoscience-based E-STEM instruction, and identifies the opportunities and challenges associated with its implementation. The findings are expected to contribute to the development of culturally responsive E-STEM pedagogy, enrich the literature on ethnoscience in Islamic elementary education, and provide practical recommendations for teachers, curriculum developers, and policymakers seeking to strengthen contextual and sustainable learning practices.

METHOD

This study employed a qualitative approach using a single-case study design to explore the integration of ethnoscience into Environmental-Science, Technology, Engineering, and Mathematics (E-STEM) learning in Madrasah Ibtidaiyah(Priya, 2021). A case study was selected because it enables an in-depth investigation of a contemporary educational phenomenon within its real-life context. The research was conducted in a Madrasah Ibtidaiyah in Deli Serdang Regency, North Sumatra, selected purposively due to its implementation of contextual learning that incorporates local wisdom into classroom instruction. The participants consisted of the principal, curriculum coordinator, classroom teachers, science teachers, and students who were directly involved in E-STEM learning activities(Werang et al., 2023). Data were collected through classroom observations, semi-structured interviews, and document analysis, including teaching modules, lesson plans, learning media, students' project portfolios, and school policy documents. Data collection was carried out over several classroom learning sessions to obtain comprehensive and contextual information regarding the implementation of ethnoscience-based E-STEM learning.

The collected data were analyzed using the interactive model proposed by Miles, Huberman, and Saldaña (2019), which consists of data condensation, data display, and conclusion drawing and verification. The analysis focused on identifying themes related to the integration of local wisdom into E-STEM learning, instructional strategies employed by teachers, students' learning experiences, implementation challenges, and best practices. To enhance the trustworthiness of the findings, credibility was established through source triangulation, method triangulation, prolonged engagement in the field, and member checking with selected participants(Erdmann & Potthoff, 2023). Transferability was supported by providing rich descriptions of the research context, while dependability and confirmability were strengthened through an audit trail documenting all stages of data collection and analysis.

Table 1. Research Informants and Data Collection Methods

No.	Informant	Data Collection Method
1	Principal	Semi-structured interview, documentation
2	Vice Principal for Curriculum	Semi-structured interview, documentation
3	Grade IV Teacher	Classroom observation, semi-structured interview, documentation
4	Grade V Teacher	Classroom observation, semi-structured interview, documentation
5	Science Teacher (if available)	Classroom observation, semi-structured

		interview
6	Students (Grade IV–V)	Classroom observation, focus group interview, students' project documentation
7	School Documents (Teaching Modules, Lesson Plans, Students' Worksheets, Assessment Sheets, Project Reports)	Document analysis

RESULT AND DISCUSSION

Result

Integration of Ethnoscience into E-STEM Learning in Madrasah Ibtidaiyah

The findings indicate that the integration of ethnoscience into Environmental-Science, Technology, Engineering, and Mathematics (E-STEM) learning has been systematically implemented in the selected Madrasah Ibtidaiyah in Deli Serdang Regency. Rather than presenting science concepts as abstract knowledge, teachers contextualized learning by utilizing students' surrounding environment and local wisdom as authentic learning resources. Local agricultural practices, medicinal plants, traditional food processing, and environmental conservation activities were integrated into classroom discussions and project-based learning activities. These local contexts enabled students to relate scientific concepts to their daily experiences, making learning more meaningful and relevant.

Classroom observations revealed that teachers began each lesson by introducing environmental issues familiar to students before connecting them with scientific concepts. During one observed lesson on ecosystems, students were asked to identify biodiversity around the school and discuss the ecological functions of plants commonly cultivated in their community. Students then worked collaboratively to investigate environmental problems and propose practical solutions using the E-STEM framework.

The observation notes showed that students actively participated in identifying local resources, discussing scientific explanations, and designing simple environmental projects. Learning activities were characterized by collaboration, inquiry, experimentation, and reflection. Rather than memorizing concepts, students developed scientific understanding through direct interaction with their environment.

The principal emphasized that contextual learning based on local wisdom had become one of the school's instructional priorities:

"*We encourage teachers to use the surrounding environment as a learning resource. Students understand science more easily when examples come from their own community rather than only from textbooks*." (Interview with the Principal, 12 May 2026)

Similarly, one classroom teacher explained:

"*Ethnoscience allows students to see that science already exists in their daily lives. Traditional farming, medicinal plants, and local environmental practices become examples that make abstract concepts easier to understand.*" (Interview with Grade V Teacher, 13 May 2026)

These findings demonstrate that ethnoscience functions as a bridge between local cultural knowledge and scientific concepts, supporting contextual and meaningful E-STEM learning.

Local Wisdom as the Foundation of E-STEM Learning

The study further found that various forms of local wisdom in Deli Serdang were successfully transformed into learning resources within E-STEM instruction. Teachers identified community knowledge that contained scientific principles before integrating it into classroom learning activities. Examples included observations of traditional irrigation systems, compost production, local medicinal plants, and environmentally friendly agricultural practices practiced by local communities.

Students were encouraged to investigate why traditional practices remained effective from scientific perspectives. Through inquiry activities, they collected observational data, discussed

scientific explanations, and designed simple experiments related to environmental sustainability. Such learning experiences promoted higher-order thinking because students compared indigenous knowledge with scientific theories learned in the classroom.

Observation data showed that students demonstrated high enthusiasm during outdoor learning sessions. They actively observed plant diversity, measured environmental conditions, recorded findings, and presented their observations collaboratively. Students also connected Islamic values of environmental stewardship with the scientific concepts they had learned.

One student stated:

"*I like learning outside the classroom because I can directly see the plants and understand why they are important for nature*." (Student Interview, 13 May 2026)

Another student added:

"*Science becomes easier because the teacher explains it using examples that exist around our homes*." (Student Interview, 13 May 2026)

Field observations also indicated increased interaction among students during collaborative investigations. Students demonstrated curiosity by asking questions, discussing observations, and proposing explanations based on evidence collected during field activities. These behaviors reflected the successful implementation of inquiry-oriented E-STEM learning.

E-STEM Learning Improves Students' Understanding

One of the most significant findings of this study is that integrating ethnoscience into E-STEM learning improved students' conceptual understanding. Teachers consistently reported that students learned scientific concepts more effectively when learning activities were connected with familiar environmental and cultural contexts.

Instead of relying solely on textbook explanations, students observed authentic phenomena before discussing scientific concepts. This instructional strategy reduced misconceptions and encouraged students to construct their own understanding through investigation and discussion.

According to the Grade IV teacher:

"*Students understand science faster because they directly observe objects around them. They no longer memorize definitions but understand concepts through real experiences*." (Interview with Grade IV Teacher, 14 May 2026)

The curriculum coordinator similarly explained:

"*Project-based E-STEM activities encourage students to investigate environmental issues independently. As a result, classroom discussions become more active, and students remember concepts much longer*." (Interview with Curriculum Coordinator, 14 May 2026)

Observation findings supported these interview data. During classroom discussions, students confidently explained relationships between biodiversity, environmental conservation, and ecosystem balance using examples taken from their own surroundings. Students also demonstrated improved communication skills while presenting project findings before classmates.

Observation notes further revealed that nearly all students actively participated in discussions, asked questions, and collaborated during project completion. Teachers acted primarily as facilitators by guiding inquiry rather than providing direct explanations throughout the lesson.

Best Practices in Integrating Ethnoscience into E-STEM Learning

The findings identified several instructional practices that contributed to successful implementation. First, teachers consistently utilized local environmental resources as learning media, enabling students to connect scientific concepts with authentic experiences. Second, project-based learning became the primary instructional strategy because it encouraged collaboration, investigation, creativity, and problem-solving. Third, teachers integrated Islamic educational values into environmental learning by emphasizing responsibility (amanah), stewardship (khalifahfilardh), environmental balance (mizan), and caring for Allah's creation.

Classroom observations showed that teachers provided opportunities for students to investigate local environmental issues, design simple solutions, and communicate their findings through presentations. Reflection sessions at the end of each lesson encouraged students to evaluate both scientific concepts and moral values learned throughout the activities.

One teacher explained:

"*Our objective is not only for students to master science but also to appreciate their local culture and become responsible for protecting the environment as part of Islamic teachings*." (Interview with Grade V Teacher, 14 May 2026)

Observation data confirmed that learning activities consistently integrated cognitive, affective, and psychomotor domains. Students demonstrated scientific investigation skills while simultaneously showing positive attitudes toward environmental conservation and respect for local cultural heritage.

Overall, the findings indicate that the integration of ethnoscience into E-STEM learning provides meaningful and contextual learning experiences for Madrasah Ibtidaiyah students. The approach successfully enhances students' conceptual understanding by connecting scientific knowledge with local wisdom and real-life experiences. Furthermore, no major implementation barriers were identified during the study because the school had developed collaborative planning among teachers and optimized the surrounding environment as an accessible learning resource. The implementation therefore represents a practical model for strengthening culturally responsive and environmentally sustainable science education in Madrasah Ibtidaiyah.

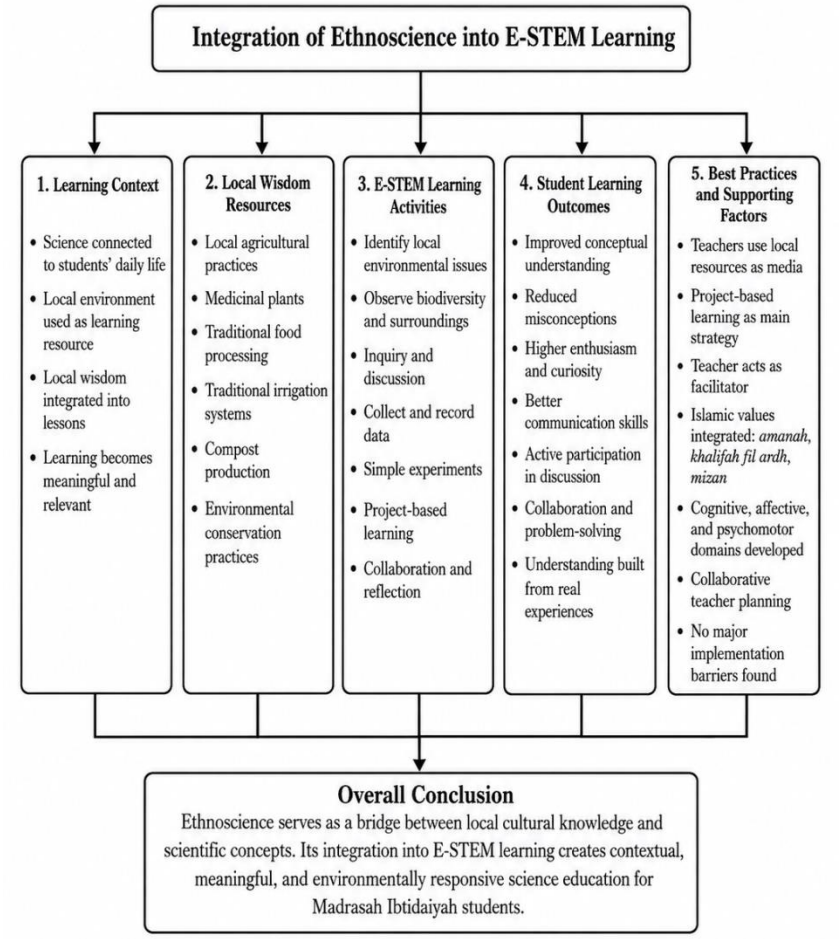


Figure 1. Framework of Ethnoscience Integration in E-STEM Learning

Discussion

The findings of this study demonstrate that the integration of ethnoscience into Environmental Science, Technology, Engineering, and Mathematics (E-STEM) learning creates a more contextual and meaningful science learning experience for students in Madrasah Ibtidaiyah. Teachers did not present science as a collection of abstract definitions that students needed to memorize. Instead, scientific concepts were introduced through local agricultural activities, medicinal plants, traditional food processing, biodiversity, and environmental conservation practices found in the students' surroundings. This approach helped students recognize that scientific knowledge is closely connected to the activities of their families and communities. Similar findings were reported by (Aisyah & Khotimah, 2023), who found that ethnoscience learning in Madrasah Ibtidaiyah enabled teachers to connect local cultural practices with formal science concepts. (AnatriDesstya&AmaliaDwiOktaviani, 2024)also explain that ethnoscience can make elementary science learning more relevant because the learning materials are drawn from situations that students already understand.

The use of local knowledge as a starting point for science learning reflects the principles of culturally responsive education. Culturally responsive science teaching recognizes students' cultural experiences, community knowledge, and social backgrounds as important learning resources. In the present study, teachers respected the knowledge students brought from their homes and communities and used it to explain formal scientific concepts. Thus, local knowledge was not treated as an outdated belief, but as an entry point for scientific investigation. Van Ingen et al. (2018) argue that integrated STEM education and culturally responsive teaching can support each other because both approaches emphasize authentic problems, students' experiences, and meaningful participation. Similarly, (Pinneo & Benton, 2024)found that effective culturally responsive science teaching requires teachers to acknowledge students' cultural backgrounds, create inclusive learning environments, and avoid viewing local knowledge as academically inferior. Therefore, the integration of ethnoscience in this study contributed not only to science learning but also to the recognition and preservation of students' cultural identities.

The transformation of local wisdom into E-STEM learning resources was another important finding. Traditional irrigation, compost production, medicinal plants, agricultural activities, and the management of natural resources contain knowledge that can be examined through scientific inquiry. Students were encouraged to observe these practices, collect information, ask questions, and compare community explanations with scientific concepts. This process is important because ethnoscience should not merely present cultural information as an additional topic. It should guide students in reconstructing community knowledge through scientific observation and reasoning. (Latip et al., 2024)explain that local and Indigenous knowledge includes daily practices, community systems, and investigation methods developed through long interactions between communities and their natural environments. (Suryanti et al., 2021)similarly emphasize that ethnoscience learning should involve the identification, verification, and scientific reconstruction of local knowledge. A systematic review by (Jannah et al., 2022)also shows that ethnoscience is frequently integrated with inquiry, discovery learning, and project-based learning because these models enable students to examine the scientific meaning of cultural practices.

The E-STEM activities observed in this study were consistent with socio-constructivist learning principles. Students developed their understanding through observations, discussions, group investigations, experimentation, and reflection. Teachers mainly acted as facilitators who provided questions and guidance rather than directly delivering all scientific explanations. This learning process allowed students to construct knowledge from authentic experiences and interactions with their classmates. (Toma et al., 2024)explain that integrated STEM learning should intentionally connect scientific inquiry, engineering design, mathematics, technology, and collaborative problem-solving. In the present study, the students observed environmental conditions, recorded information, discussed ecological problems, and proposed simple solutions.

These activities illustrate that E-STEM learning was not limited to combining several subject names but involved the application of different forms of knowledge to solve contextual problems. The findings are also consistent with (Sumarni et al., 2022), who demonstrated that Indigenous knowledge of traditional medicinal plants can be scientifically reconstructed and incorporated into STEM activities to create meaningful science learning.

The findings further indicate that ethnoscience-based E-STEM learning improved students' conceptual understanding. Students understood scientific concepts more easily when explanations were connected to objects and activities that they could directly observe. For example, concepts related to ecosystems, biodiversity, plant functions, and environmental balance were discussed through plants and environmental conditions around the school. Students were therefore able to move from concrete observations to more abstract scientific explanations. This finding supports (Verawati & Wahyudi, 2024), who state that local wisdom-based science learning improves scientific literacy by connecting scientific concepts with familiar social and environmental conditions. (Rahmawati et al., 2020)also found that the integration of ethnopedagogy into science learning improved conceptual understanding, student engagement, communication, collaboration, and cultural awareness. Familiar contexts reduce the distance between school science and students' everyday lives, making it easier for students to organize new information based on their previous experiences.

However, the reported improvement in conceptual understanding should be interpreted carefully. The present study used qualitative evidence obtained through observations, interviews, and document analysis. Therefore, the findings demonstrate changes in students' participation, explanations, confidence, and ability to connect concepts with real situations rather than statistically measured learning gains. Students were observed explaining relationships among biodiversity, environmental conservation, and ecosystem balance using examples from their surroundings. Teachers also reported that students remembered scientific concepts longer when they learned through direct observation and projects. These qualitative indicators provide strong evidence of meaningful learning, although further research using pre-tests, post-tests, or scientific literacy assessments would be required to determine the magnitude of the improvement.

Project-based and collaborative activities also contributed to active student participation. The students did not only listen to the teacher but investigated environmental issues, shared tasks, discussed evidence, designed simple projects, and presented their findings. These learning activities supported communication, creativity, collaboration, and problem-solving skills. Muskania et al. (2024) found that teachers consider STEM-PjBL materials based on local wisdom necessary for improving scientific literacy and making science instruction more relevant to students. (Rosyidah et al., 2025b)Rosyidah et al. (2025) similarly conclude that STEM provides an interdisciplinary framework through which local wisdom can be transformed into contextual science activities that support the achievement of quality education. Thus, project-based E-STEM learning gives students opportunities to apply scientific concepts rather than simply repeat information provided by the teacher.

The students' active participation during outdoor observations also indicates that the surrounding environment functioned as an accessible learning laboratory. Students observed plant diversity, measured environmental conditions, recorded findings, asked questions, and communicated their conclusions. This type of learning is especially suitable for elementary-level students because it provides concrete experiences before introducing abstract explanations. It also reduces teachers' dependence on expensive laboratory facilities. The school environment, community activities, traditional foods, agricultural systems, and medicinal plants can serve as learning resources when teachers are able to identify their scientific content. Consequently, ethnoscience-based learning can be implemented even in schools with limited technological or laboratory equipment, although teachers still require adequate pedagogical knowledge to design systematic E-STEM activities.

Another significant finding was the integration of environmental responsibility and Islamic educational values. Teachers connected environmental learning with the concepts of *amanah*, *khalifahfilardh*, *mizan*, and respect for Allah's creation. This integration shows that the learning objectives were not limited to cognitive achievement. Students were also guided to develop environmental awareness, moral responsibility, and positive attitudes toward their cultural heritage. (Sihombing et al., 2025)explain that ethnoscience can strengthen environmental education because traditional practices often contain knowledge about resource management, biodiversity, and relationships between communities and nature. This finding is consistent with the Education for Sustainable Development framework, which emphasizes that education should develop the knowledge, skills, values, and attitudes needed to make responsible environmental decisions (UNESCO, 2020). Therefore, the combination of ethnoscience, E-STEM, and Islamic values offers a comprehensive learning approach covering cognitive, affective, spiritual, and practical dimensions.

The integration of Islamic values did not replace scientific explanations. Instead, religious values provided an ethical foundation for applying scientific knowledge. For example, understanding ecosystem balance was connected with the responsibility to avoid damaging nature, while studying plant diversity was related to gratitude and respect for Allah's creation. This relationship is important in Madrasah Ibtidaiyah because science education and religious character development should support each other. The approach allows students to understand environmental conservation as both a scientific necessity and a moral responsibility. It also distinguishes ethnoscience-based E-STEM learning in a madrasah context from similar practices in general elementary schools.

Interestingly, the study did not identify major barriers during implementation. This finding differs from previous studies that frequently report limited teaching materials, insufficient teacher knowledge, limited professional development, and difficulties in designing interdisciplinary activities. (Aisyah &Khotimah, 2023)and Oktaviana et al. (2024), for example, indicate that the successful implementation of ethnoscience depends heavily on teachers' ability to identify relevant cultural knowledge and connect it with curriculum content. ("A Qualitative Study of Teacher's Perspective about Digital STEM-PjBL Teaching Material Based on Local Wisdom to Improve Scientific Literacy," 2024)also found that many teachers still depend on government or commercial textbooks and rarely develop their own STEM materials based on local wisdom. In the present study, these barriers appeared to be reduced by collaborative lesson planning, school leadership support, and the use of accessible environmental resources. This interpretation suggests that ethnoscience-based E-STEM does not always require complex facilities when teachers receive institutional support and are willing to use their immediate environment creatively.

Nevertheless, the absence of major barriers in one school should not be generalized to all Madrasah Ibtidaiyah. The selected school already had experience in contextual learning and had established collaboration among teachers(Ali et al., 2024). Other schools may have different levels of teacher readiness, cultural resources, infrastructure, and administrative support. (Pinneo & Benton, 2024)emphasize that culturally responsive teaching requires continuous teacher learning because teachers must understand both subject content and students' cultural contexts. (Latip et al., 2024) also recommend more systematic curriculum development to ensure that local knowledge is integrated accurately into science education. Therefore, professional development should help teachers identify local practices, examine their scientific principles, develop E-STEM projects, and design authentic assessments.

Overall, this study confirms that ethnoscience can function as a pedagogical bridge connecting local knowledge, formal science, environmental sustainability, and Islamic values. Its contribution lies not only in making science lessons more interesting but also in changing how students understand the relationship between science and their communities. Through observations, inquiry, collaborative projects, and reflection, students became active participants

who investigated scientific concepts within familiar cultural and environmental contexts. The findings therefore support the development of culturally responsive and environmentally oriented E-STEM learning in Madrasah Ibtidaiyah.

Future studies should examine the implementation of this approach in several madrasahs with different social, cultural, and geographical characteristics. Quantitative or mixed-method research could measure its effects on scientific literacy, critical thinking, environmental attitudes, collaboration, and learning achievement. Longitudinal research is also needed to determine whether students' cultural appreciation and environmental responsibility continue beyond the learning activities. In addition, cooperation among teachers, local cultural experts, parents, and community members should be explored to ensure that local knowledge is represented accurately and respectfully. Such efforts would strengthen ethnoscience-based E-STEM as a sustainable instructional model for Islamic elementary education.

CONCLUSION

The findings of this study demonstrate that the integration of ethnoscience into E-STEM learning in Madrasah Ibtidaiyah effectively creates meaningful, contextual, and student-centered learning experiences. By utilizing local wisdom as a learning resource, teachers successfully connected scientific concepts with students' daily lives through project-based and inquiry-oriented activities. This instructional approach enhanced students' conceptual understanding, promoted active participation, strengthened collaboration and problem-solving skills, and encouraged greater environmental awareness. The integration of Islamic values, particularly *amanah*, *khalifahfilardh*, and environmental stewardship, further enriched students' cognitive, affective, and behavioral development.

The study concludes that ethnoscience-based E-STEM learning represents an effective pedagogical model for Madrasah Ibtidaiyah because it simultaneously strengthens scientific literacy, preserves local cultural heritage, and supports character education. Future studies are recommended to investigate the effectiveness of this approach in different educational contexts and to develop ethnoscience-based E-STEM learning modules that can be implemented more broadly across Islamic elementary schools in Indonesia.

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