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Integration of Ethnoscience into Environment-STEM Learning in Elementary Schools : An Islamic Education Perspektive

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Abstract

This study examines the integration of ethnoscience into Environment-STEM learning in elementary schools in Pacitan Regency from an Islamic education perspective. Using a qualitative case study in ten public and Islamic elementary schools, data were collected through observations, interviews, and documentation and analyzed interactively. The findings show that local wisdom was transformed into Environment-STEM modules through Batik Pace, Wayang Beber, and local traditions, while Project-Based Learning promoted contextual and environmental problem solving. Islamic education served as a pedagogical framework by integrating the values of khalifah fil ardh, amanah, ihsan, and mizan into learning objectives, instructional strategies, and assessment. The study proposes a novel Environment-STEM pedagogical model that advances environmental literacy, scientific literacy, sustainable character, and culturally responsive education.

Keywords: *Ethnoscience; Environment-STEM; Islamic Education.*

Integrasi Etnosains dalam Pembelajaran Environment-STEM di Sekolah Dasar: Perspektif Pendidikan Islam

Abstrak

Penelitian ini bertujuan menganalisis integrasi etnosains dalam pembelajaran Environment-STEM di sekolah dasar Kabupaten Pacitan dari perspektif pendidikan Islam. Penelitian menggunakan pendekatan studi kasus kualitatif pada sepuluh sekolah dasar negeri dan Islam. Data dikumpulkan melalui observasi, wawancara mendalam, dan dokumentasi, kemudian dianalisis dengan model interaktif. Hasil penelitian menunjukkan bahwa kearifan lokal direkonstruksi menjadi modul Environment-STEM melalui Batik Pace, Wayang Beber, dan berbagai tradisi lokal, sedangkan Project-Based Learning mendorong pembelajaran kontekstual dan pemecahan masalah lingkungan. Perspektif pendidikan Islam berfungsi sebagai kerangka pedagogis dengan mengintegrasikan nilai khalifah fil ardh, amanah, ihsan, dan mizan ke dalam tujuan, strategi, serta evaluasi pembelajaran. Penelitian ini menghasilkan model pedagogis Environment-STEM yang memperkuat literasi lingkungan, literasi sains, karakter berkelanjutan, dan pendidikan yang responsif terhadap budaya.

Kata kunci: *Etnosains; Environment-STEM; Pendidikan Islam.*

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A. Introduction

The transformation of 21st-century education demands a shift in the learning paradigm, moving away from a mere orientation toward conceptual mastery to the development of critical thinking, creative, collaborative, and communicative abilities, alongside environmental awareness as part of students' global competencies.[1] This condition is increasingly relevant in light of contemporary challenges such as climate change, environmental degradation, natural resource crises, and the loss of local knowledge due to massive modernization. In this context, primary education occupies a strategic position as the foundation for character building, environmental literacy, and the strengthening of students' cultural identity from an early age.[2] Therefore, learning approaches that integrate environmental issues as authentic contexts, scientific inquiry, technological design, engineering practices, mathematics, and local wisdom have become increasingly important to equip students with sustainability competencies rather than merely disciplinary knowledge.

The Environment-STEM approach has emerged as an advancement of conventional STEM by positioning environmental sustainability not merely as learning content but as the central context that drives scientific inquiry, engineering design, and decision-making.[3] Unlike conventional STEM, which generally emphasizes interdisciplinary integration to solve technological or engineering problems, Environment-STEM requires students to investigate authentic environmental issues, analyze ecological impacts, design sustainable solutions, and evaluate their consequences within social and environmental contexts. Its instructional syntax commonly involves identifying local environmental problems, conducting scientific investigations, designing and testing solutions, reflecting on sustainability impacts, and communicating findings collaboratively. Consequently, Environment-STEM extends beyond developing scientific and technological competencies by fostering environmental literacy, systems thinking, sustainability awareness, and responsible citizenship. These characteristics distinguish

[1] Ari Hasan Ansori and M. Arie Firdaus Heriansyah, *Transformasi Pembelajaran Abad 21: Sinergi Proyek Kontekstual Dan Penilaian Autentik Mewujudkan Pembelajaran Mendalam* (Goresan Pena, 2025).

[2] Rizky Sandy Adhitama et al., "Kesadaran Metakognitif Siswa Dalam Pembelajaran Berbasis Proyek Pada Pokok Bahasan Pencemaran Lingkungan," *Assimilation: Indonesian Journal of Biology Education* 1, no. 1 (2018): 39–45.

[3] Shahad Alkair et al., "A STEM Model for Engaging Students in Environmental Sustainability Programs through a Problem-Solving Approach," *Applied Environmental Education & Communication* 22, no. 1 (2023): 13–26.

Environment-STEM from conventional STEM and other inquiry-based learning models that may emphasize scientific processes without explicitly integrating environmental sustainability as the organizing framework.[4]

In Indonesia, the implementation of Environment-STEM learning faces challenges, notably the ongoing dominance of textbook-sourced materials without optimizing the surrounding environment's potential as a learning laboratory.[5] Science learning in elementary schools often occurs abstractly, causing students to struggle to connect scientific concepts with the realities of daily life. In fact, the Merdeka Curriculum provides ample space for teachers to develop learning based on local contexts through projects for strengthening the Pancasila Student Profile (P5) as well as differentiated learning that adapts to regional characteristics.[6] This open opportunity paves the way for the integration of ethnoscience as a relevant learning resource for students' lives. Consequently, the contextual and environmental orientation of Environment-STEM aligns closely with the objectives of the Merdeka Curriculum, which encourages project-based, contextual, and locally relevant learning experiences.

Ethnoscience is scientific knowledge that develops within a society through a long process of experience and is passed down from generation to generation in the form of practices, traditions, local technology, and environmental management systems. Snively and Corsiglia stated that "Indigenous knowledge represents a sophisticated body of knowledge developed through generations of interaction with the environment" (p. 16).[7] This statement demonstrates that local knowledge is not merely a cultural tradition but contains scientific principles that can serve as a science learning resource. Thus, ethnoscience functions not only as a source of scientific knowledge but also as the contextual basis through which students investigate environmental problems, design solutions, and construct scientific understanding within the Environment-STEM framework.

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[4] Toni Norman Hanafi and Ahmad Rifandi, "Implementation of the Strengthening the Pancasila Student Profile Project (P5) on Character Development of Elementary School Students," *At Turots: Jurnal Pendidikan Islam*, 2025, 892–99; Yoko Mochizuki and Edward Vickers, *Still 'the Conscience of Humanity'? UNESCO's Vision of Education for Peace, Sustainable Development and Global Citizenship*, in *Compare: A Journal of Comparative and International Education*, vol. 54, no. 5 (Taylor & Francis, 2024).

[5] Suyuti et al., *STEM For The Future: Mencetak Generasi Inovatif Dengan Pembelajaran Interdisiplin*.

[6] Hanafi and Rifandi, "Implementation of the Strengthening the Pancasila Student Profile Project (P5) on Character Development of Elementary School Students."

[7] Gloria Snively and John Corsiglia, "Discovering Indigenous Science: Implications for Science Education," *Science Education* 85, no. 1 (2001): 6–34; I. Wayan Suja, "Revitalisasi Etnosains Untuk Mendukung Literasi," *Bivalen: Chemical Studies Journal* 5, no. 1 (2022): 01–10.

Pacitan Regency is a region possessing a wealth of ethnoscience with immense potential to be developed in Environment-STEM learning. Its geographical characteristics, consisting of karst landscapes, mountains, the southern coast, underground rivers, and biodiversity, provide authentic learning resources for elementary school students. Furthermore, the community of Pacitan maintains various local practices, such as water spring conservation, season-based agricultural land management, the utilization of family medicinal plants, marine product processing techniques, and traditions for preserving forests and coastal areas, all of which naturally contain concepts of science, technology, engineering, and mathematics. Hitherto, this potential has not been optimally utilized within elementary school education, leaving students to mostly study universal scientific concepts without relating them to the environment in which they live. These contextual resources provide authentic environmental problems that correspond directly to the investigative and design phases of Environment-STEM learning.

The integration of ethnoscience in Environment-STEM also has strong relevance to the perspective of Islamic Education. Islam views humans as khalifah fil ardh (vicegerents on earth) who hold the trust (amanah) to prosper the earth while maintaining natural balance. The Qur'an asserts, "And do not cause corruption on the earth after its reformation" (QS. Al-A'raf: 56).[8] This verse indicates that environmental preservation is part of implementing Islamic values. According to Al-Qaradawi, environmental conservation is a form of social worship because it relates to the welfare of all living creatures.[9] Thus, Environment-STEM learning that utilizes local ethnoscience not only develops students' academic competence but also internalizes the values of tawhid (monotheism), amanah, ihsan (perfection/ benevolence), responsibility, and ecological awareness in daily life. Within this framework, Islamic values guide the formulation of learning objectives, the selection of environmentally responsible learning activities, and the evaluation of students' ecological attitudes and ethical decision-making.

The perspective of Islamic Education views knowledge as an inseparable unity between revelation and reason (integrated knowledge). This concept rejects the dichotomy between religious science and general science because all knowledge essentially originates from Allah SWT and must be used to achieve human welfare.

[8] Fitriati Husna and Muhammad Sarjan, "Peran Manusia Sebagai Khalifah Dalam Menjaga Lingkungan Hidup Melalui Etika Lingkungan Serta Korelasinya Dengan Surat Al-A'raf Ayat 56," *Lambda: Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya* 4, no. 3 (2024): 161–68.

[9] Didiek Noeryono Basar et al., "Implementing Yusuf Al-Qaradawi's Fiqh Al-Bi'ah Values to Strengthen Environmental Literacy at UIN Raden Mas Said Surakarta," *Muslim Heritage* 11, no. 1 (2026).

In the context of Environment-STEM learning, the integration of Islamic values can be realized through strengthening spiritual awareness of natural phenomena as signs of Allah's greatness (ayat kauniyah), instilling habits of environmental care as an implementation of noble character (akhlak mulia), and developing scientific thinking skills grounded in Islamic ethical and moral values. As put forward by Ashoumi and Yusuf,[10] scientific integration is an approach that completely connects empirical, rational, and spiritual dimensions so that education can produce individuals who are both characterful and competitive. Accordingly, Islamic Education serves as a conceptual framework that integrates scientific reasoning with ethical responsibility, ensuring that Environment-STEM learning simultaneously develops cognitive competence, environmental stewardship, and spiritual character.

Various previous studies indicate that ethnoscience-based learning can enhance students' scientific literacy, critical thinking skills, creativity, and environmental awareness.[11] Other research also proves that a local wisdom-based STEM approach provides more meaningful learning experiences because students learn through contexts close to their lives.[12] However, most of these studies still focus on the secondary education level and have not widely examined the integration of ethnoscience into Environment-STEM learning in elementary schools, particularly from the perspective of Islamic Education. Furthermore, previous studies rarely explain how ethnoscience, Environment-STEM pedagogy, and Islamic educational principles can be integrated into a coherent instructional framework for elementary education. In addition, research concerning the utilization of Pacitan Regency's rich ethnoscience as an Environment-STEM learning resource remains highly limited, meaning a conceptual model to serve as a reference for elementary school teachers is not yet available.

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[10] Hilyah Ashoumi and Moh Asror Yusuf, "Pendidikan Inklusi: Integrasi Konsep Konstruktivistik Vygotsky Dan Landasan Al-Qur'an Untuk Mendukung SDGs 4," *Intelektual: Jurnal Pendidikan Dan Studi Keislaman* 14, no. 3 (2024): 321–44, https://doi.org/10.33367/ji.v14i3.6308.

[11] Isma Izzatun Nabilla et al., "Eksplorasi Inovasi Pembelajaran Ilmu Pengetahuan Alam Untuk Meningkatkan Literasi Sains Pada Generasi Digital," *Jurnal Pendidikan Dan Pembelajaran* 5, no. 01 (2026); Indri Wahyuni et al., "Dampak Perubahan Terhadap Jam Kerja Dan Stres Kerja Terhadap Kinerja Karyawan," *Innovative: Journal Of Social Science Research* 5, no. 4 (2025): 10205–13; Muhammad Syazali and Umar Umar, "Peran Kebudayaan Dalam Pembelajaran IPA Di Indonesia: Studi Literatur Etnosains," *Jurnal Educatio Fkip Unma* 8, no. 1 (2022): 344–54.

[12] Dewi Ayu Pratiwi and Arief Setiawan, "Inovasi Pembelajaran Stem Berbasis Kearifan Lokal Untuk Peningkatan Literasi Sains Siswa," *Jurnal Dinamika Pendidikan Islam* 1, no. 2 (2025): 47–58; Indri Sari Utami et al., "Pengembangan STEM-A (Science, Technology, Engineering, Mathematic and Animation) Berbasis Kearifan Lokal Dalam Pembelajaran Fisika," *Jurnal Ilmiah Pendidikan Fisika Al-Biruni* 6, no. 1 (2017): 67–73.

Based on the background above, there are research gaps in three major areas. First, there is still a lack of studies integrating local ethnoscience with the Environment-STEM approach at the elementary school level. Second, few studies have linked Environment-STEM implementation with Islamic Education values as a philosophical foundation for environmental learning. Third, there has been no comprehensive exploration of Pacitan Regency's ethnoscience potential as a contextual and sustainable learning resource. Therefore, this study is crucial to developing a conceptual framework for integrating ethnoscience into Environment-STEM learning based on Islamic Education values, thereby strengthening environmental literacy, ecological character, 21st-century competencies, and preserving the local wisdom of the Pacitan community. Therefore, this study proposes a novel pedagogical framework integrating Pacitan ethnoscience, Environment-STEM pedagogy, and Islamic educational values into a coherent learning model. This framework contributes theoretically by extending the conceptual development of Environment-STEM through the integration of sustainability education, local wisdom, and Islamic pedagogy, while practically providing elementary school teachers with a contextual model for implementing the Merdeka Curriculum.

B. Research Methods

This study used a qualitative approach with a case study design aimed at deeply exploring the integration of ethnoscience into Environment-STEM learning in elementary schools in Pacitan Regency, reviewed from the perspective of Islamic Education. The research locations were selected purposively across several elementary schools that have implemented Environment-based contextual learning and utilized local potential as a learning resource. Research informants included school principals, classroom teachers, Islamic Education teachers, students, and community figures who understand the practices of local wisdom in the research area. Data were obtained through participant observation, in-depth interviews, and documentation studies of teaching modules, lesson plans, student projects, and other supporting documents. Data validity was ensured through source triangulation, technical triangulation, member checking, and prolonged observation to guarantee the credibility of the research findings.

Data analysis was conducted interactively using the Miles, Huberman, and Saldaña model, which includes data condensation, data display, and conclusion

drawing and verification.[13] The analysis process was carried out simultaneously from data collection until the completion of the study, enabling the researchers to discover patterns, themes, and relationships between categories regarding the implementation of ethnoscience in Environment-STEM learning. The analysis results were then interpreted using an Islamic Education perspective by examining the links between local ethnoscience values, Environment-STEM principles, and Islamic concepts concerning humans as khalifah fil ardh, amanah, and environmental preservation. This approach is expected to generate a comprehensive understanding of the ethnoscience integration model in learning capable of strengthening elementary students' environmental literacy, ecological character, and Islamic values.

C. Results and Discussion

Mapping and Scientific Reconstruction of Pacitan's Local Ethnoscience as an Environment-STEM Learning Resource

The results showed that Pacitan Regency possesses a diverse wealth of local wisdom that is full of scientific values, which can be reconstructed into ENVIRONMENT-STEM-based learning resources. Teachers at the studied schools no longer view local culture merely as traditional heritage but develop various forms of local wisdom into contextual learning modules that connect cultural knowledge with concepts of science, technology, engineering, and mathematics. Thus, ethnoscience is positioned as a learning medium that bridges students' cultural experiences with modern scientific concepts.

Based on field observations, there are three main groups of local wisdom widely used as learning resources: Batik Pace Pacitan as a medium for learning about natural dyes, geometric patterns, and production processes; Wayang Beber Pacitan as a learning medium for history, art, visual technology, and cultural communication; and community traditions and rituals, such as Sedekah Laut, Ceprotan, or other local traditions integrated into learning about environmental preservation, social values, and character. All these forms of local wisdom were then developed into teaching materials, project modules, and Environment-STEM based learning activities tailored to the characteristics of the students.

Observation Notes (SD Alam Pacitan & SD Negeri 1 Sedeng): "Students observe the motifs of Batik Pace Pacitan to identify geometric shapes and

[13] Johnny Saldana, *Thinking Qualitatively: Methods of Mind* (SAGE publications, 2014).

learn the process of making natural dyes used by artisans. The teacher guides the students to discuss the relationship between natural ingredients, the color-mixing process, and the value of local cultural preservation. The observation results are then documented in a project-based worksheet as part of the Environment-STEM learning module."

This integration combines the science aspect through the study of natural coloring agents and chemical changes, technology through the batik production process, engineering through the design of motifs and simple products, and mathematics through the analysis of patterns, symmetry, and the measurement of batik motifs. Islamic Education teachers and classroom teachers also link this learning to the concept of maintaining cultural heritage as a form of gratitude to Allah SWT and as a means of preserving the identity of the Pacitan community.

Interviews with school management showed that the utilization of local wisdom was intentionally done to present learning that is more contextual and close to students' lives. As stated by the Principal of SD Islam Insan Cendekia:

"We design learning modules that utilize Pacitan's local culture so that children learn from their own cultural environment. Batik Pace, Wayang Beber, and community traditions become engaging learning media so that students not only understand science concepts but also love their regional culture. Through this kind of learning, they learn that preserving culture is part of their responsibility as humans entrusted with an amanah by Allah."[14].

Similar findings were observed in public schools. Teachers have started utilizing the flexibility of the Merdeka Curriculum to develop teaching modules based on local wisdom. A Grade V Teacher at SD Negeri 1 Kayen explained that Wayang Beber is used as a cross-disciplinary learning medium:

"We use Wayang Beber not only to introduce Pacitan's history but also as a learning tool. The children study the storyline as part of literacy, observe coloring techniques as a science concept, redesign wayang characters using simple digital applications as a technology element, and then create miniature wayang scrolls as part of engineering. So, local culture truly becomes a complete learning resource." [15]

Through this scientific reconstruction, Pacitan's local wisdom functions as an epistemological bridge in Environment-STEM learning. Scientific concepts that were previously abstract become easier to understand because they are learned through

[14] Interview with the Principal of SD Islam Insan Cendekia, February 12, 2026
[15] Interview with a Grade V Teacher at SD Negeri 1 Kayen, February 18, 2026

a culture already known to students in their daily lives. The utilization of local culture as a learning module also strengthens cultural identity while increasing student engagement in the learning process.

Implementation of Project-Based Environment-STEM Learning Models and Environmental Characteristics

The implementation of ethnoscience-based Environment-STEM in ten elementary schools in Pacitan Regency was dominated by the Project-Based Learning (PjBL) approach, integrated into the Project for Strengthening the Pancasila Student Profile (P5) as well as differentiated intracurricular learning. The learning process is no longer confined to delivering material inside the classroom but utilizes various local wisdoms of Pacitan as learning resources packaged in the form of modules, projects, learning media, and exploratory activities. Through this approach, students not only study STEM concepts but also understand local cultural values as part of the regional identity that needs to be preserved.

In integrated Islamic schools like SDIT Ar Rahmah and SD Integral Hajar Aswad, Environment-STEM projects were developed through the utilization of Batik Pace Pacitan, Wayang Beber Pacitan, and various local traditions as cross-disciplinary learning contexts. Teachers arranged learning modules that integrated elements of science, technology, engineering, and mathematics with the exploration process of local culture so that students gained contextual and meaningful learning experiences. The following are observation notes from SDIT Ar Rahmah:

"In the school's project room, a group of fourth-grade students is seen observing the process of creating Batik Pace Pacitan motifs to identify geometric patterns, symmetry, and the use of natural dyes. In another group, sixth-grade students document Wayang Beber Pacitan through digital media, then redesign wayang characters using simple applications as part of an Environment-STEM project. The teacher facilitates a discussion on the relationship between the process of creating cultural works and the concepts of science, technology, engineering, and mathematics contained within them."

The formulation of STEM in these activities appeared fully integrated. Students used the scientific method to identify natural dye materials, utilized digital technology in the documentation and design process of local culture, designed creative products based on Wayang Beber and Batik Pace, and applied mathematical concepts through pattern analysis, measurement, and motif symmetry. The

Curriculum Coordinator of SDIT Ar Rahmah explained that the project design was compiled collaboratively by teachers across subjects:

"The application of Environment-STEM in our school requires collaboration among classroom teachers, science teachers, art teachers, and Islamic Education teachers. For instance, in the Batik Pace Pacitan project, the science teacher guides students to understand the process of making natural dyes and material properties, the math teacher directs the analysis of patterns and motif symmetry, the art teacher guides the visual design, while the religion teacher links cultural preservation as a form of gratitude to Allah and the responsibility to protect ancestral heritage. The final outcome can be in the form of modules, simple batik products, digital media, or ENVIRONMENT-STEM-based project reports." [16]

In public schools, the implementation of Environment-STEM also demonstrated the utilization of local wisdom as a learning resource according to the characteristics of each school. SD Negeri 1 Sirnoboyo and SD Negeri Ploso developed learning projects based on Wayang Beber, Batik Pace, and various cultural traditions of the Pacitan community packaged as cultural exploration projects and the production of learning media. A Grade VI Teacher at SD Negeri Ploso explained that this approach made it easier for students to understand STEM concepts because they were directly linked to the culture they had known since childhood:

"The children are actually already familiar with Pacitan's culture, but they don't yet understand that behind Batik Pace, Wayang Beber, or the Sedekah Laut tradition lie many scientific concepts that can be studied. Through ethnoscience-based Environment-STEM, we develop learning modules that invite students to document local culture, analyze batik patterns, create miniature Wayang Beber, and compile digital presentations about the meaning of these traditions. They learn science, technology, engineering, and mathematics while simultaneously growing a sense of pride in their regional culture." [17]

The main challenge found in the implementation of learning was the readiness of teachers to reconstruct various forms of local wisdom into learning modules capable of integrating the four STEM components in a balanced manner. Nonetheless, the flexibility of the Merdeka Curriculum provides room for teachers to develop local culture-based teaching modules tailored to the characteristics of the school and the students' environment. This condition drives the birth of various

[16] Interview with the Curriculum Coordinator of SDIT Ar Rahmah, February 24, 2026.
[17] Interview with a Grade VI Teacher at SD Negeri Ploso, March 4, 2026.

learning innovations that not only reinforce 21st-century skills but also foster appreciation for the preservation of Pacitan's local wisdom as part of the nation's cultural identity.

Integration of Islamic Education Values in Environment-STEM Learning: Shaping Ecological Character (Ecological Citizenship)

The most distinctive finding of this study is the strong internalization of Islamic Education values as an ethical-philosophical foundation in ethnoscience-based Environment-STEM learning. Both private Islamic schools and public schools integrated Islamic values into the utilization of various local wisdoms of Pacitan as learning resources, so that cultural preservation is viewed not merely as an academic activity but as a form of practicing Islamic teachings in maintaining the trust (amanah) of Allah SWT. Through this approach, students are guided to understand that local culture is a part of community identity that must be guarded, developed, and passed on to the next generation.

The three main theological pillars integrated into learning are the concepts of Khalifah fil Ardh (humans as guardians of the earth and civilization), Amanah (the responsibility to protect cultural heritage and the environment), and Ihsan (doing good through the preservation of local cultural values beneficial to society). These three values became the ethical foundation for all Environment-STEM based learning activities that utilize Pacitan's local wisdom.

Observation Notes (SD Al Muhajirin & SD Negeri 1 Sambong): "Before starting the project to create the Batik Pace Pacitan module and document Wayang Beber, the Islamic Education teacher leads a collective prayer and recites QS. Al-Hujurat verse 13 on the importance of recognizing cultural diversity as part of Allah's creation. The teacher then explains that preserving local culture is a form of gratitude for Allah's blessings and an amanah to preserve national identity. On the whiteboard, a diagram shows the relationship between Islamic values, cultural preservation, and the development of knowledge through ENVIRONMENT-STEM learning. The students appear enthusiastic about linking religious material with the cultural projects they are working on."

This integration eliminates the dichotomy between religious science, general science, and local culture. Various local wisdoms of Pacitan, such as Batik Pace, Wayang Beber, and traditional customs, are not only understood as cultural heritage but are also reconstructed into learning media that have a scientific basis as well as spiritual values reinforced by arguments from the Qur'an and Hadith. The Principal

of SD Al Muhajirin explained how Islamic values serve as the foundation for the execution of Environment-STEM learning:

"We do not want children to only be capable of creating products or understanding STEM concepts, but also to possess a character that loves their regional culture. At SD Al Muhajirin, Environment-STEM serves as a tool for implementing the integration of monotheistic knowledge (tauhid keilmuan). When students study Batik Pace Pacitan or Wayang Beber, they do not only learn about the process, patterns, or manufacturing technology, but also understand that keeping cultural heritage is a form of gratitude to Allah, respecting the work of predecessors, and fulfilling the mandate as a vicegerent on earth." [18]

The internalization of these values has proven effective in shaping the character of students to have a care for the preservation of local culture and the surrounding environment. At SD Negeri 1 Sambong, Islamic Education values are instilled through habits integrated with various ethnoscience-based Environment-STEM projects. The Student Affairs Coordinator of SD Negeri 1 Sambong stated:

"Even though we are a public school, the majority of students come from a religious community environment. Therefore, we teach that preserving Batik Pace, knowing Wayang Beber, respecting community traditions, and guarding cultural products are part of the amanah given by Allah. The children become prouder of their own culture while understanding that science can be used to preserve and develop regional cultural heritage." [19]

Theoretically, the triadic integration between Environment-STEM as a scientific learning approach, ethnoscience based on Pacitan's local wisdom as a source and module for learning, and Islamic Education as an ethical-spiritual foundation has successfully formed a holistic learning model in elementary schools. This model not only develops 21st-century skills (critical thinking, collaboration, creativity, and communication) but also nurtures a religious character, an appreciation for local culture, and a commitment among students to preserve Pacitan's local wisdom as a part of cultural identity and national civilization.

In brief, the interconnectedness of the research components in the field can be described in the following conceptualization table:

[18] Interview with the Principal of SD Al Muhajirin, March 10, 2026
[19] Interview with the Student Affairs Coordinator of SD Negeri 1 Sambong, March 17, 2026

Table 1. Integration Framework of Environment-STEM Components with Pacitan Local Ethnoscience and Islamic Education Values

Environment-STEM Component	Pacitan Local Ethnoscience (Learning Source/Module)	Islamic Education Value (Ethical-Spiritual)	Student Achievement Indicators
Science	Batik Pace Pacitan (natural dyes, raw materials, manufacturing process), Wayang Beber Pacitan, and various local traditions reconstructed into scientific learning materials.	Ayat Kauniyah, contemplation (tafakkur) of Allah's creation, gratitude for cultural diversity as a blessing from Allah SWT.	Increased contextual scientific literacy, ability to observe cultural phenomena scientifically, and understanding of science concepts based on real life.
Technology & Engineering	Utilization of Batik Pace, Wayang Beber, traditional ceremonies, and local crafts as media, projects, and Environment-STEM learning modules based on simple or digital technology.	Amanah, Ihsan, and responsibility in preserving and developing cultural heritage through beneficial innovations.	Problem-solving skills, creative thinking, designing products/projects, utilizing digital technology, and producing works based on local culture.
Mathematics	Analysis of patterns, symmetry, measurement, proportion, and geometry in Batik Pace motifs, the layout of Wayang Beber, and numeracy elements in various local cultural products.	Values of thoroughness (itqan), scientific honesty (sidq), discipline, and responsibility in the learning process.	Contextual numeracy skills, pattern and data analysis, mathematical reasoning, and application of mathematical concepts in local cultural products.

Discussion

The theme of ethnoscience reconstruction emerged through iterative coding of observation notes, interview transcripts, and learning documents. Across the ten schools, recurring patterns indicated that teachers consistently transformed local cultural practices into scientific inquiry activities rather than presenting them solely as cultural knowledge. This analytical process demonstrates that the central finding is not merely the use of local wisdom in classrooms, but the systematic reconstruction of indigenous knowledge into Environment-STEM learning resources.

The results of the study show that the integration of Pacitan's local ethnoscience into Environment-STEM learning generates a transformation of the learning paradigm from being conceptual to contextual and based on real-world experiences (experiential learning). This finding reveals that local knowledge (indigenous knowledge) is no longer positioned as a traditional heritage of folkloric nature, but is reconstructed into scientific knowledge that can be explained through modern scientific approaches. This reconstruction is apparent in learning practices that utilize Batik Pace Pacitan, Wayang Beber Pacitan, and various local traditions and rituals as learning resources analyzed through the perspectives of science, technology, engineering, and mathematics, turning them into contextual learning modules.

This finding reinforces the view of UNESCO 2023 that education oriented toward sustainability (Education for Sustainable Development/ESD) will be more effective if developed based on the social, cultural, and ecological context of the local community.[20] Thus, local wisdom does not merely become an object of cultural introduction, but serves as an authentic laboratory that allows students to build scientific concepts inductively through learning experiences close to their lives. This finding forms the first component of the proposed conceptual model, namely Ethnoscience Reconstruction, in which local wisdom functions as the starting point for scientific inquiry, environmental investigation, and interdisciplinary learning.

This finding also aligns with the concept of culturally responsive STEM education, which places local culture as the main learning resource in building students' scientific literacy. According to Medin and Bang, science learning that

[20] Niken Vioreza et al., "Education for Sustainable Development: Bagaimana Urgensi Dan Peluang Penerapannya Pada Kurikulum Merdeka?," *PUSAKA: Journal of Educational Review* 1, no. 1 (2023): 34–48, https://doi.org/10.56773/pjer.v1i1.11.

integrates indigenous knowledge is capable of enriching scientific ways of thinking because students understand the relationship between cultural practices, scientific development, and community sustainability simultaneously.[21] Unlike previous studies that primarily positioned indigenous knowledge as contextual learning content, the present study demonstrates that ethnoscience also functions as an organizing principle for interdisciplinary learning. Rather than being an additional cultural component, local wisdom structures students' scientific investigations, engineering design processes, and mathematical reasoning within authentic environmental contexts. This finding extends culturally responsive STEM by showing that indigenous knowledge simultaneously supports environmental literacy, scientific reasoning, and cultural sustainability within a single pedagogical framework.

This perspective is visible in this study when teachers link the production process of Batik Pace Pacitan, the geometric patterns of batik motifs, the documentation of Wayang Beber, and various local traditions with concepts of science, digital technology, product engineering, and mathematics.[22] The public's knowledge regarding natural dyeing processes, techniques for creating cultural works, and the symbolic meanings of traditions is not only understood as an inherited habit but is reconstructed into scientific concepts that can be explained through Environment-STEM learning. As stated by Bang and Medin, "Indigenous ways of knowing provide important resources for understanding ecological systems".[23] This statement indicates that local knowledge possesses scientific legitimacy that can become the foundation for contemporary science learning while reinforcing the preservation of regional cultural identity.

From the perspective of constructivism, the process of reconstructing ethnoscience found in this study demonstrates that students build scientific concepts through direct interaction with the social and cultural environment they know. This is in line with the social constructivism theory put forward by Vygotsky that learning takes place optimally when students obtain meaningful experiences through interaction with the environment and cultural communities.[24] Teachers in

[21] Douglas L. Medin and Megan Bang, "Culture in the Classroom," *Phi Delta Kappan* 95, no. 4 (2013): 64–67.

[22] Margaret M. Bruchac, "Indigenous Knowledge and Traditional Knowledge," in *Encyclopedia of Global Archaeology* (Springer, 2020).

[23] Yulia Nesterova, "Rethinking Environmental Education with the Help of Indigenous Ways of Knowing and Traditional Ecological Knowledge," *Journal of Philosophy of Education* 54, no. 4 (2020): 1047–52.

[24] Ashoumi and Yusuf, "Pendidikan Inklusi."

this study act as mediators who help transform various forms of Pacitan's local wisdom into systematic scientific concepts so that students do not only memorize theories but are able to connect theories with the cultural reality around them. Such an approach is proven to enhance critical thinking skills because students are presented with cultural observation activities, motif analysis, learning media design, digital documentation, and the compilation of local wisdom-based projects requiring observation, interpretation, and problem-solving processes.

This condition reinforces the research results by Kelley and Knowles, which explain that STEM integration becomes effective when all fields of study are used in an integrated manner to solve authentic problems found in students' lives.[25] From Vygotsky's perspective, local cultural practices function as mediational tools that bridge students' everyday experiences and formal scientific concepts. Consequently, ethnoscience is not simply contextual content but becomes the cultural scaffold through which higher-order thinking develops. This interpretation explains why students demonstrated stronger analytical and problem-solving abilities, suggesting that cultural mediation constitutes a key mechanism underlying the effectiveness of Environment-STEM learning.

The implementation of project-based Environment-STEM (Project-Based Learning) found in this study indicates that the wealth of Pacitan's local wisdom becomes the primary factor in determining the themes of learning projects. Schools developed various projects based on Batik Pace Pacitan, Wayang Beber Pacitan, documentation of local traditions, and the development of culture-based learning media adjusted to the characteristics of each school and the cultural potential around it. Cross-case analysis further revealed a consistent instructional sequence across schools despite differences in project themes. The sequence consists of (1) identification of local environmental and cultural issues, (2) ethnoscience exploration, (3) interdisciplinary Environment-STEM investigation, (4) project design and implementation, (5) reflection on sustainability values, and (6) communication of project outcomes. This recurring pattern represents the pedagogical process underlying the proposed Environment-STEM model.

This differentiation shows that Environment-STEM implementation does not follow a uniform learning model but is adapted to the cultural characteristics

[25] Oktanti Mulvidatin and Labibah Kurniawati, "Pentingnya Pengetahuan Pedagogis Umum Dalam Praktik Instruksional STEM Pada Guru Matematika Dasar Agar Terciptanya Pembelajaran Bermakna," *EduSpirit: Jurnal Pendidikan Kolaboratif* 1, no. 1 (2024): 307–13.

possessed by each school. This finding supports the research by Jolly, which explains that STEM learning will be more meaningful if designed based on real-world problems so that students have the opportunity to integrate various disciplines to solve problems they encounter in daily life.[26] According to English, "STEM education should engage students in solving authentic problems that require interdisciplinary thinking."[27] This statement is highly relevant to the findings of this study when students analyze Batik Pace motifs, digitalize Wayang Beber, design learning media based on local culture, and then evaluate the results of these projects through a scientific approach.

Furthermore, Environment-STEM implementation that utilizes local wisdom as a living laboratory demonstrates a shift in learning orientation from teacher-centered to student-centered learning. Teachers are no longer the sole source of information, but function as facilitators who direct students to conduct observations, cultural explorations, simple experiments, product designs, and reflections on the results of the developed projects. This approach is in line with the characteristics of the Merdeka Curriculum, which provides flexibility to schools to develop learning based on local contexts through the Project for Strengthening the Pancasila Student Profile (P5). Conceptually, the results of this study show that the implementation of ethnoscience-based PjBL produces learning that integrates 21st-century competencies in the form of critical thinking, collaboration, creativity, and communication (4C). This finding is consistent with the results of research by Wibowo,[28] which asserts that learning based on projects and real problem solving can improve higher-order thinking skills while building sustainability competence.

More importantly, the findings indicate that Environment-STEM, ethnoscience, and Islamic Education operate as mutually reinforcing dimensions rather than independent instructional components. Ethnoscience provides contextual content, Environment-STEM offers the interdisciplinary learning process, while Islamic Education supplies ethical and sustainability-oriented values that guide learning objectives, instructional activities, and assessment. This integrated relationship constitutes the principal novelty of the study because

[26] Anne Jolly, *STEM by Design: Tools and Strategies to Help Students in Grades 4–8 Solve Real-World Problems* (Routledge, 2024).

[27] Lyn D. English, "Ways of Thinking in STEM-Based Problem Solving," *ZDM – Mathematics Education* 55, no. 7 (2023): 1219–30, https://doi.org/10.1007/s11858-023-01474-7.

[28] Widodo Setiyo Wibowo, "Implementasi Model Project-Based Learning (Pjbl) Dalam Pembelajaran Sains Untuk Membangun 4cs Skills Peserta Didik Sebagai Bekal Dalam Menghadapi Tantangan Abad 21," *Seminar Nasional Ipa V*, 2014, 275–86.

previous studies generally discussed these dimensions separately. Accordingly, the proposed conceptual framework expands existing Environment-STEM literature by positioning local wisdom and Islamic educational values as integral elements of sustainable STEM pedagogy.

To synthesize the findings across the ten elementary schools, this study proposes a conceptual model of ethnoscience-based Environment-STEM learning from an Islamic Education perspective. As presented in Figure 3, the model illustrates the integration of Pacitan local ethnoscience, Environment-STEM pedagogy, and Islamic educational values into a coherent framework that guides learning processes and promotes scientific literacy, environmental literacy, sustainability character, cultural preservation, and twenty-first-century competencies.

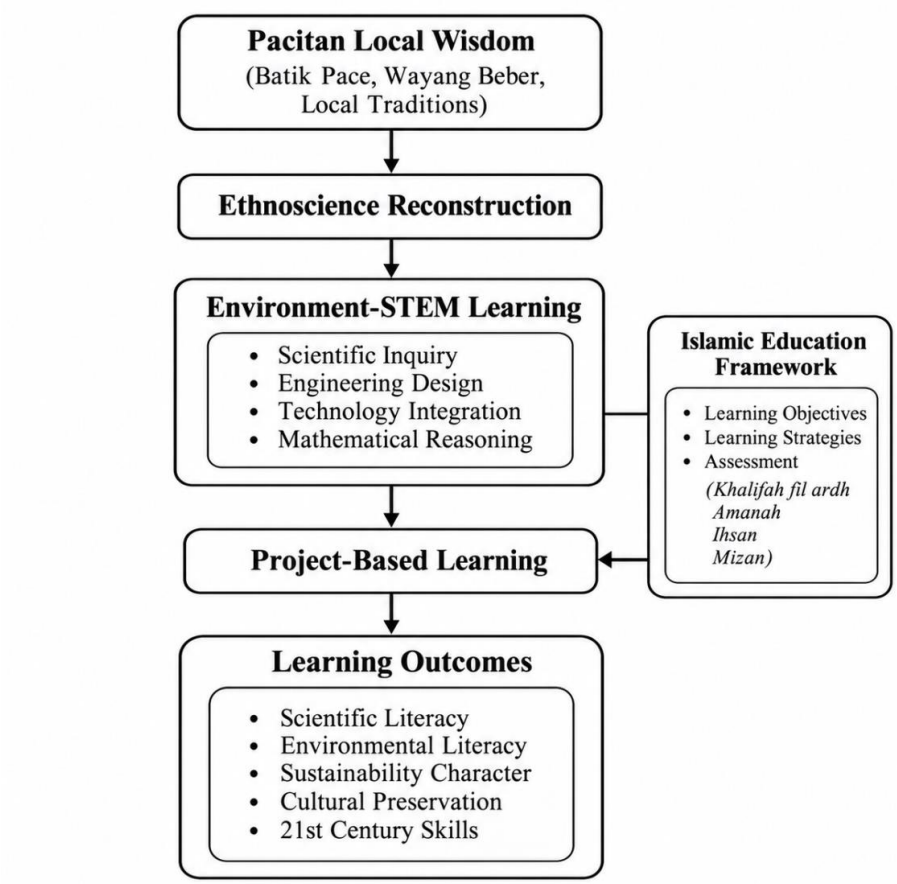

Figure 1. Conceptual Model of Ethnoscience-Based Environment-STEM Learning from an Islamic Education Perspective

D. Conclusion

This study demonstrates that the integration of ethnoscience into Environment-STEM learning in elementary schools in Pacitan Regency has formed a learning model that is contextual, collaborative, and oriented toward sustainability through the utilization of various local wisdoms of Pacitan as scientific learning resources and modules. The reconstruction of local ethnoscience, such as Batik Pace Pacitan, Wayang Beber Pacitan, and various other local traditions, cultural ceremonies, and customs, successfully connected elements of science, technology, engineering, and mathematics into learning experiences close to students' lives, thereby increasing contextual scientific literacy, critical thinking skills, creativity, problem-solving skills, and appreciation for local culture. The implementation of project-based learning combined with Islamic Education values, especially the concepts of khalifah fil ardh, amanah, ihsan, and mizan, reinforces the formation of a religious character, responsibility, and care among students in preserving local wisdom as a part of Allah SWT's trust, so that cultural preservation is understood not just as an academic activity but as a form of moral, social, and spiritual responsibility. Thus, the ethnoscience-based Environment-STEM integration model from the perspective of Islamic Education becomes an innovative alternative relevant to supporting the implementation of the Merdeka Curriculum while strengthening the preservation of local wisdom, the development of culture-based learning, character education, and sustainable educational development in elementary schools.

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