Ethnoscience of Dadak Merak Reog: Integrating local wisdom into science learning of students in Ponorogo

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Abstract. This study explores the ethnoscientific values embedded in the traditional *Dadak Merak* art of Reog Ponorogo and their potential integration into science learning. The research aims to (1) identify ethnoscience elements in *Dadak Merak* Reog from the perspective of the SETS components (Science, Environment, Technology, and Society); and (2) explore the challenges and opportunities in integrating ethnoscience-based learning in secondary schools in Ponorogo Regency. This research employs a qualitative descriptive approach to deeply understand the meanings, values, and practices of ethnoscience within the *Dadak Merak* Reog tradition and their relation to science education. Data were collected through observation, interviews with cultural practitioners, and document analysis in several secondary schools. The findings reveal that *Dadak Merak* Reog embodies rich ethnoscientific aspects such as principles of balance, force, motion, and material use that can be contextualized in science learning. Integrating these cultural elements not only enhances students' understanding of scientific concepts but also nurtures cultural appreciation and conservation-oriented attitudes. It is recommended that science educators incorporate local ethnoscientific knowledge into the curriculum to promote meaningful learning in science.

1 Introduction

Natural Science consists of four main components: products, processes, attitudes, and applications [1], with its object of study being natural phenomena that have already occurred [2]. This object of study is closely related to local wisdom, which encompasses knowledge, beliefs, perspectives, customs, and ethics that guide community behavior in a particular region. This is often referred to as the study of ethnoscience. Unfortunately, ethnoscience remains minimally integrated into education, especially in science learning, including the development of learning media or resources. This lack of integration may contribute to the fading of students' cultural conservation character [3], since the preservation of local wisdom is generally carried out collectively by institutions or local governments. Consistent with Yasir [3], this decline occurs due to the lack of attention to socio-cultural environments within scientific studies. In relation to ethnoscience and local wisdom, Ponorogo Regency in East Java Province is well known for its traditional performing art, *Reog*. Moreover, UNESCO has recognized *Reog* as an authentic cultural performance [4]. Local wisdom is often associated with food, language, customs, and socio-cultural traditions. *Reog* represents one form of socio-cultural wisdom that continues to develop in Ponorogo [5]. As a cultural heritage, *Reog* is highly popular among tourists visiting Ponorogo, and in fact, this performance art has spread to various cities across Indonesia and even been showcased abroad [6]. Ethnoscientific studies of *Reog Ponorogo*—particularly in the use of the *Dadak Merak* mask or giant fan, which symbolizes a combination of two animals, the tiger and the peacock [7] are essential for integration into science learning [8]. This aligns with the current curriculum (Merdeka Curriculum), which emphasizes students' exploration of factual social issues as integrated science learning themes. Ethnoscience implementation involves integrating each region's local wisdom into project-based learning or other collaborative learning models [9,10]. The *Dadak Merak* is closely related to science material on the classification of matter and its changes, with components such as *rengkek* (rattan, bamboo, nails, and wool thread), *krakap* (velvet fabric, beads, and thread), *embong* (thread and fabric), and peacock feathers (*bulu plong*, *bulu rawis*, and *bulu cawang*)[11]. Additionally, in the P5 (Pancasila Student Profile) theme of global diversity, this integration can foster competencies and characters such as cultural heritage conservation [3]. This also aligns with Vygotsky's social constructivism theory, which emphasizes the importance of applying social contexts and interactions outside the classroom, particularly in developing cultural conservation character [12]. In the future, educators are encouraged to integrate local wisdom into learning activities [13]. Several previous studies have explored local wisdom from different regions, such as Yasir [3], who studied the ethnoscience of *Madura keris* from a STEAM perspective, and Agustina [14], who focused on the ethnoscience within *Reog* dance movements. The traditional performance of the Reog

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Ponorogo, particularly the iconic mask known as Dadak Merak, has received increasing scholarly attention as a repository of local wisdom and as a resource for learning science. Prior studies have explored its aesthetic-symbolic aspects, the underlying physics and geometry in its movement and structure, and its potential role in curricular innovations that align with ethnoscience. Interfacing these threads provides a foundation for integrating the Dadak Merak motif into science teaching in elementary or secondary contexts, particularly within the culture-rich district of Ponorogo, East Java. On the aesthetic and symbolic dimension, for example, Wardani examined how the form of the Dadak Merak mask functions as cultural signifier in Reog performances, emphasising how peacock feathers and lion-head motifs combine to convey local identity and pride. They argue that the mask is not merely ornamentation, but a cultural text with layers of meaning for the community [26]. From a science-educational perspective, Wulansari investigated the physics concepts embedded in the movement of Dadak Merak within Reog: specifically, the notions of equilibrium and moment of force manifest when the dancer bears the heavy mask and performs dynamic movements [27]. Their qualitative descriptive study identified that the cultural practice is a viable "science from culture" context, and argued that ethnoscience-based teaching has potential to enhance students' scientific literacy and creative thinking. In terms of local wisdom education and pedagogical development, Munawaroh et al. developed an interactive student-book (the "ETINTEC Student Book") for teaching ecology and biodiversity in Ponorogo based on ethnoscience and the local culture, including elements like the Reog mask. Study highlights how anchoring science instruction in local cultural assets can improve relevance and student interest. Moreover, research on the symbolic meaning and local-wisdom education embedded in Reog shows that the performance conveys values such as leadership, cooperation and environmental awareness, thus reinforcing its role as an educational medium beyond pure aesthetics.In sum, these studies collectively suggest that the Reog performance, and specifically the Dadak Merak element, provide multiple entry points for science learning: through physics/movement, structural/engineering aspects (mask weight, balance), geometry (shape of feathers and mask) and cultural-value dimensions [28]. However, while prior work documents the presence of scientific insight in the Reog tradition and has developed prototype teaching materials, gaps remain: (1) detailed empirical research on student learning outcomes when Dadak Merak–based ethnoscience modules are implemented; (2) robust curricular integration of local wisdom and science across grade levels and disciplines; (3) explorations of how the local community's wisdom (crafting the mask, managing peacock feathers, heritage knowledge) supports a full ethnoscience pedagogy. Therefore, the proposed study of integrating Dadak Merak local wisdom into science learning aims to build on this groundwork by designing, implementing and evaluating learning modules in the Ponorogo context, thereby contributing to both theoretical and practical fields of ethnoscience education.In contrast, this study aims to identify elements of ethnoscience from the SETS (Science, Environment, Technology, Society) perspective and analyze how the integration of ethnoscience can be implemented in science learning particularly at the secondary school level. Furthermore, the urgency of this research lies in its contribution to the *Ethnosocio-Science* course within the Department of Science Education, which requires extensive field-based insights and phenomena related to ethnoscience.

2 Method

This study employs a qualitative approach with a descriptive research design. The qualitative approach was chosen because this research aims to deeply understand the meanings, values, and ethnoscientific practices embedded in the *Dadak Merak Reog Ponorogo* art form, as well as its relationship with science learning and students' cultural heritage conservation character at the secondary school level in Ponorogo Regency. The qualitative descriptive design allows the researcher to systematically describe the phenomena under study without manipulating variables, emphasizing instead the exploration of data from the participants' perspectives. The subjects of this research are junior high school students and science teachers in Ponorogo Regency. The objects of the research are the *Dadak Merak Reog* art, which contains elements of ethnoscience. Data were collected through participant observation, in-depth interviews, and documentary study. In-depth interviews with science teachers and junior high school students explored their understanding of ethnoscience in *Dadak Merak* and its relevance to science education and cultural heritage conservation. Meanwhile, documentary study involved gathering school records, photos, videos, and literature related to *Dadak Merak Reog Ponorogo* as supporting data. This is the flowchart diagram of research method.

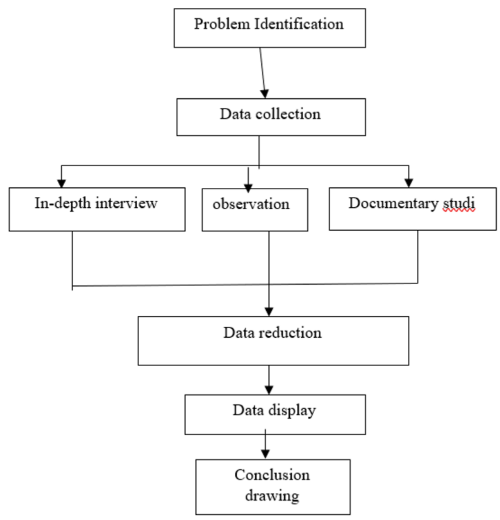

Fig. 1. Research method flowchart.

3 Result and discussion

This research was conducted in four secondary schools representing different regions of Ponorogo Regency. The first site was *SMP Negeri 6 Ponorogo*, located at Jl. HOS Cokroaminoto No.84, Bangunsari, Ponorogo, East Java. This urban-based school was selected because it offers a *Reog* extracurricular program, has achieved various non-academic awards in local cultural activities, and is recognized as one of the most reputable schools in the region. One experienced science teacher and several grade VIII students were interviewed to explore their understanding of cultural heritage conservation. The second site was *MTs Negeri 1 Ponorogo*, located on Jl. Jenderal Sudirman No. 24A, Jetis District, which actively participates in the annual *Reog* Festival held by the local government. During the data collection at this school, one science teacher from *MTs Negeri 2 Ponorogo* (Jl. Ki Ageng Mirah No.79, Plampitan, Japan, Ponorogo) was also included as a respondent due to the school's excellence and achievements as a leading state Islamic junior high school in the region. The fourth location was *MTs Muhammadiyah 1 Ponorogo*, located at Jl. Stadion Timur No.20B, Ronowijayan, Babadan District, chosen because it serves as a visiting lecture site for pre-service science education students from UIN Kiai Ageng Muhammad Besari Ponorogo. Although this school does not yet have a formal *Reog* extracurricular unit, many students are actively involved in *Reog* performances. In total, four science teachers and four students from these four different schools were selected as the main informants through in-depth interviews. Additional teachers and students also participated as supporting data sources during observation and documentation activities.

3.1 Identification of ethnoscience elements in the Dadak Merak Reog art from the SETS (Science, Environment, Technology, and Society) Perspective

The results of interviews with four science teachers (coded as Teachers G1–G4) revealed that the *Dadak Merak Reog Ponorogo* art possesses significant potential as a source of science learning when viewed through the components of Science, Environment, Technology, and Society (SETS). The coded responses from the four teachers can be summarized as follows in Table 1.

All four teachers acknowledged that the *Dadak Merak Reog* performance contains relevant scientific elements, particularly in physics (force, balance, muscular strength), biology (muscle function, conservation of living organisms), and chemistry (material properties, synthetic coloring). The environmental aspect is reflected in discussions on peacock conservation and the issue of using real versus synthetic feathers. The technological element is evident in the craftsmanship involved in making the *Dadak Merak*, which requires specific skills in material selection and construction techniques. Meanwhile, the societal aspect is closely related to *Reog Ponorogo* traditions as a symbol of local cultural identity that appears in various social and ceremonial events. Thus, the *Dadak Merak Reog* art can be operationalized in science learning through the SETS (Science, Environment, Technology, and Society) approach, where each component provides authentic contexts for science concepts in the classroom. *Ethnoscience* refers to the process of transforming indigenous or community-based knowledge into formal scientific concepts [16]. Local wisdom is understood as indigenous knowledge or local intelligence derived from the noble values of cultural traditions. Indigenous scientific knowledge encompasses all forms of understanding related to community life, originating from beliefs passed down through generations [15]. A strategic approach to revitalizing ethnoscience is its integration into formal science education [24]. Integrating indigenous knowledge into the science curriculum is appropriate, as indigenous ways of interacting with nature embody distinct cultural perspectives and are grounded in their own theoretical frameworks [25]. Meanwhile, scientific knowledge is studied theoretically or empirically through experiments, research, and literature to validate the authenticity and accuracy of traditional knowledge within a scientific framework. The environmental dimension is closely tied to current conservation issues, particularly the ethical debate between using real versus synthetic peacock feathers. This discourse promotes environmental ethics and encourages learners to consider the sustainability of cultural practices [18]. Meanwhile, the technological aspect is revealed through the intricate craftsmanship and construction techniques used by local artisans. The artisans employ skills in selecting natural materials such as rattan, bamboo, and wood, combining traditional technology with creative innovation [21]. The societal component of *Reog Ponorogo* reflects deep-rooted cultural traditions associated with community celebrations, cooperation (*gotong royong*), and cultural identity. These practices strengthen social cohesion and preserve cultural heritage [20]. Through the SETS (Science, Environment, Technology, and Society) framework, *Dadak Merak Reog* serves as an effective pedagogical medium for contextual science learning. Each SETS component provides authentic, culturally relevant examples that bridge scientific theory with local wisdom [17]. Integrating ethnoscientific contexts into science education enables students to connect abstract concepts with real-world cultural practices, fostering critical thinking, environmental responsibility, and cultural appreciation [19]. According to Arfianawati et al[16], *ethnoscience* refers to the transformation of indigenous and community-based knowledge into formal scientific understanding. Local wisdom represents the intellectual heritage of a community that emerges from its cultural values, traditions, and lived experiences. As Ahmadi and Linuwihexplain, indigenous knowledge evolves through intergenerational transmission and reflects empirical observations grounded in local contexts. When this indigenous knowledge is examined through systematic experimentation and theoretical analysis, it transitions into scientific knowledge a process that validates traditional practices within a modern scientific paradigm [15]. Thus, the study of *Dadak Merak Reog* exemplifies how ethnoscience can serve as a bridge between traditional knowledge systems and contemporary science education, promoting both scientific literacy and cultural sustainability.

Table 1. Coding result for SETS aspect.

SETS Aspect	Main Findings	Example Teacher Quotes
Science	Concepts Identified: Force; Muscular Force; Balance; Material Properties; Additives/Substances and Natural Coloring Agents; Conservation of Living Organisms	"...terkait gaya dan keseimbangan dadak merak pada saat pertunjukan..." (G1)
Environ-ment	Peacock conservation;The issue of using real versus synthetic feathers;Environmental awareness	"...materi konservasi in-situ, ex-situ terutama hewan merak..." (G1); "...konservasi hewan yaitu merak hijau..." (G2)
Technology	The technique of making the Dadak Merak;The selection of materials (rattan, bamboo, wood); Craftsmanship skills	"...teknik pembuatan dadak merak itu sendiri...harus seniman yang ahli..." (G2)
Society	Ponorogo traditions (celebrations, circumcision ceremonies, festivals);Mutual cooperation or community solidarity;Local cultural identity	"...tradisi masyarakat Ponorogo jika ada hajatan, khitan, pesta pernikahan ada Reog..." (G1); "...unsur gotong royong, dan menunjukkan keharmonisan..." (G2)

3.2 Challenges and opportunities in integrating *Reog* ethnoscience into science learning

Based on the interviews with four science teachers, several challenges emerged in integrating the ethnoscientific aspects of *Dadak Merak Reog* into science learning. The main pedagogical challenge lies in the difficulty of linking cultural phenomena directly to science content. Teachers reported struggling to identify clear connections between Reog traditions and scientific concepts such as physics, biology, or chemistry. As one teacher noted, *"We often use Reog as an example in class discussions, but there is no written guide or module, so we just improvise."* (Teacher G2). This reflects the lack of structured teaching materials and limited pedagogical guidance on contextual science teaching [22]. Another recurring challenge involves teachers' limited understanding of ethnoscience. Several respondents admitted they were not yet confident in analyzing scientific elements within cultural artifacts (G3, G4). This gap in teacher competence often leads to superficial integration, where local culture is only mentioned briefly rather than explored scientifically. Institutional limitations also emerged, as not all schools have formal cultural preservation programs, and existing initiatives tend to focus on extracurricular rather than academic integration (G4). Additionally, environmental and material constraints arise due to the limited availability of real peacock feathers, as peacocks are now protected species, creating tension between cultural preservation and wildlife conservation [18]. Despite these challenges, the study identified several promising opportunities. First, teachers highlighted a high degree of relevance between Reog and science content, particularly in concepts such as force, material properties, and conservation, which align well with the current curriculum (G1–G4). The Merdeka Curriculum supports this integration by encouraging the incorporation of local wisdom and community-based contexts into learning by Kemendikbud [23]. Second, most schools in Ponorogo have extracurricular Reog programs, which can serve as cultural laboratories for connecting traditional arts with scientific inquiry. This setting allows students to observe real phenomena such as balance, energy transfer, and material durability within authentic contexts. Teachers also reported positive student character development outcomes. When learning is connected to local culture, students show increased enthusiasm, curiosity, and pride in their cultural identity. One teacher explained, *"Students seem more excited when we discuss science through Reog examples because it feels closer to their daily life."* (G1). Such findings align with studies indicating that ethnoscience-based education strengthens students' cultural awareness and environmental responsibility [19]. Furthermore, integrating Reog in science learning can foster cultural conservation values, as students develop respect and commitment toward preserving local heritage [3]. From a broader perspective, the findings suggest that integrating *Dadak Merak Reog* ethnoscience into science education involves both pedagogical and institutional barriers, yet offers substantial contextual and affective benefits. Using the SWOT framework, the *strengths* include Ponorogo's strong cultural identity and the scientific relevance of Reog phenomena. The *weaknesses* lie in teachers' limited pedagogical competence and the scarcity of ethnoscience-based learning resources. The *opportunities* are provided by national education policies, cultural programs, and local government support following UNESCO's recognition of Reog Ponorogo as Intangible Cultural Heritage. However, *threats* include the risk of cultural commodification and the potential loss of traditional meaning if Reog is only treated as entertainment rather than heritage. To maximize these opportunities, several strategic steps are recommended: (1) developing ethnoscience-based teaching modules that explicitly connect Reog phenomena with scientific principles; (2) organizing teacher training on contextual and culturally responsive pedagogy; and (3) fostering collaboration between schools and Reog artist communities to ensure authenticity and sustainability. With these efforts, the integration of ethnoscience in science learning not only enriches students' scientific understanding but also contributes to the preservation of cultural heritage and local identity.

4 Conclusion

The ethnoscience elements in *Dadak Merak Reog* can be identified through the SETS framework (Science, Environment, Technology, and Society). From the science perspective, *Reog* art reflects concepts of physics (force, balance, and pivot), biology (structure of peacock feathers and biodiversity), and chemistry (natural dyeing processes). From the environment perspective, *Reog* demonstrates connections to wildlife and environmental conservation issues. From the technology aspect, it shows local innovations in the techniques used to create the *Dadak Merak*. Meanwhile, from the society perspective, *Reog* serves as a symbol of identity, tradition, and community cooperation among the people of Ponorogo. The integration of *Dadak Merak Reog* ethnoscience into science learning at the secondary school level has been shown to enhance students' enthusiasm, understanding, and engagement. Teachers use *Reog* phenomena as contextual examples in science instruction, although they still face challenges such as limited learning resources and insufficient pedagogical skills to fully implement ethnoscience-based approaches.

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