

# The Urgency of Developing Ethno-ESD-Based Teaching Modules in Elementary School Science Education Based on Local Wisdom Dodol Garut

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## Abstract

This study aims to analyze the need for developing Ethno-ESD-based teaching modules in elementary school science education by utilizing the local wisdom of Garut dodol making as a learning context. The study uses an exploratory qualitative approach with an instrumental case study design in the fourth grade of SDN 1 Bojong. Data were obtained through semi-structured interviews, learning observations, and document analysis, then analyzed using thematic analysis. The results show that the integration of local culture in science learning is still incidental and not yet structured in a systematic teaching module design. In addition, the values of Education for Sustainable Development (ESD) have not been explicitly integrated, so that learning tends to focus on cognitive aspects and has not developed systemic, reflective, and anticipatory thinking competencies. The findings also indicate that local culture has significant potential to encourage student creativity if designed within an integrated pedagogical framework. This study produced a conceptual model of an Ethno-ESD-based teaching module that places local culture as the triggering context, science concepts as the scientific core, and sustainability and creativity competencies as the transformative orientation of learning. This study contributes to strengthening the integration of ethnoscience and ESD in basic science education and provides a conceptual foundation for the development of contextual and sustainable teaching modules.

## Keywords:

Ethno-ESD; Science Learning; Local Culture; Sustainability; Creativity

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## A. Introduction

Science education in elementary schools plays a strategic role in building the foundations of scientific literacy and 21st-century competencies, including creativity and problem-solving skills. However, various studies show that science education still tends to focus on the transfer of abstract concepts and fails to relate the material to the real-life contexts of students (OECD, 2019; (Bybee, 2013). As a result, learning becomes less meaningful and less than optimal in developing creative thinking skills (Beghetto & Kaufman, 2014). This condition shows a gap between the curriculum's emphasis on contextual learning and classroom learning practices that are still conceptual and textual in nature.

The ethnoscience approach offers an

alternative by integrating local knowledge as a bridge to understanding scientific concepts (G. Aikenhead & Michell, 2011). Research shows that local culture-based learning can increase student motivation and understanding because the material becomes relevant to their daily experiences (Bang & Medin, 2010; Ulfah et al., 2020). On the other hand, Education for Sustainable Development (ESD) emphasizes the integration of environmental, social, and economic dimensions in education to build awareness of sustainability from an early age (United Nations Educational & Organization (UNESCO), 2017). The integration of ESD in science learning has been proven to encourage critical and solution-oriented thinking on sustainability issues (Wals & Benavot, 2017).

However, previous studies tend to

discuss ethnoscience and ESD separately. Ethnoscience research emphasizes the relevance of local culture in science learning without explicitly linking it to the dimension of sustainability. Conversely, ESD research often focuses on global issues without being rooted in specific local cultural practices (Pauw et al., 2015). Thus, there is a conceptual and empirical gap in simultaneously integrating ethnoscience and ESD into systematic learning designs, especially at the elementary school level. This gap raises fundamental questions about the extent to which local culture and sustainability values have been integrated into current science learning practices.

Field study results show that the teaching modules used have met the Merdeka Curriculum structure, but have not explicitly integrated local culture and sustainability values. Learning activities are still dominated by simple experiments with single answers and do not provide space for exploring ideas that encourage student creativity. Teachers expressed the need for contextual, structured, and flexible teaching modules to systematically integrate local culture and ESD. Meanwhile, students showed high enthusiasm for practice-based learning and real-life contexts. These findings reinforce the gap between curriculum expectations and classroom implementation.

The local wisdom of dodol Garut production has the potential to integrate scientific concepts (changes in form, heat transfer, physical and chemical changes), cultural values (patience, perseverance, mutual cooperation), and sustainability principles (use of local materials, production efficiency, waste minimization). However, this potential has not been constructed as a systematic context for science learning. This raises the question of how local cultural practices can be used as an integrative context to connect science, culture, and sustainability in science learning.

This study departs from the need to thoroughly understand how current science learning in elementary schools combines

sustainability and local cultural values. This is done because of existing conceptual and empirical inconsistencies. First, it is important to determine the actual conditions of education for sustainable development (ESD) and the integration of local culture in science learning. This is done to determine the extent to which learning has systematically accommodated socio-cultural contexts and sustainability issues. Furthermore, it is necessary to analyze the needs of teachers and students to develop Etno-ESD-based teaching modules, specifically to support more structured, contextual learning that encourages student engagement. In addition, this study examines the prospects of local wisdom regarding the making of Garut dodol as an integrative context that can connect science ideas with cultural values and sustainability principles. Ultimately, these findings are directed toward formulating the characteristics of Etno-ESD-based teaching modules needed to support the development of creative thinking in elementary school students. Thus, this series of questions not only aims to identify existing gaps but also to build a conceptual foundation for the development of more contextual, sustainable, and creativity-oriented learning designs.

Theoretically, this research contributes to the development of an integrative framework between ethnoscience and Education for Sustainable Development (ESD) in primary science education by positioning cultural and sustainability dimensions as a unified foundation for learning design. Empirically, it addresses a significant research gap by providing a conceptual basis for the development of contextual and creativity-oriented Etno-ESD-based teaching modules. Practically, the findings offer guidance for teachers in designing science learning that is more relevant, meaningful, and aligned with the implementation of the Merdeka Curriculum. However, despite the recognized importance of integrating local knowledge and sustainability, there remains a lack of systematic and structured

implementation in current classroom practices, particularly in the form of teaching modules. Therefore, this study is directed to answer several key questions, namely: to what extent local cultural values and sustainability principles have been integrated into current primary science learning; what the needs of teachers and students are regarding the development of Ethno-ESD-based teaching modules; how local wisdom, particularly the practice of Garut dodol production, can function as an integrative context linking scientific concepts, cultural values, and sustainability principles; and what key characteristics of Ethno-ESD-based teaching modules are required to support the development of creative thinking in primary school students. Thus, the urgency of developing Ethno-ESD-based teaching modules grounded in local wisdom not only responds to contextual needs in elementary education but also contributes to advancing sustainable and future-oriented science education.

## B. METHOD

This study uses an exploratory qualitative approach with an instrumental case study design to gain an in-depth understanding of the integration of local wisdom and Education for Sustainable Development (ESD) in elementary school science education and to formulate a conceptual basis for the development of Ethno-ESD-based teaching modules. The case study design was chosen because it allows for comprehensive contextual exploration of educational phenomena in real settings (Stake, 1995; Yin, 2018). The research was conducted at SDN 1 Bojong in Grade IV as the main location for data collection, involving a total of 35 students. The selection of the fourth grade was based on the suitability of the science material with the concepts of changes in the form of objects, heat energy, and simple scientific processes that are contextual to the practice of making Garut dodol as a form of ethnoscience. This approach is in line with the view that the integration of local

knowledge in science education can bridge scientific and cultural ways of knowing (G. Aikenhead & Michell, 2011). The research participants consisted of one fourth-grade teacher, several students who were selected purposively based on their active involvement in learning, and one dodol craftsman as a representative of local knowledge sources. The purposive sampling technique was used to ensure that the participants had relevant experience with the research focus (Creswell & Poth, 2016). The study was conducted over a period of three months, from October to December 2025, allowing sufficient time for in-depth data collection and analysis.

Data collection was conducted through semi-structured interviews, learning observations, analysis of teaching module documents, and contextual observations of the Garut dodol production process. Semi-structured interviews allowed for in-depth exploration of the experiences and meanings constructed by participants (Kvale & Brinkmann, 2009). Classroom observations were conducted to identify pedagogical practices and teacher-student interactions in context-based science learning (Tisdell et al., 2025). Document analysis was used to evaluate the extent to which the teaching modules integrated local cultural elements and ESD principles (Bowen, 2009). The ESD framework refers to sustainability competencies that include systems thinking, reflective thinking, and anticipatory thinking (United Nations Educational & Organization (UNESCO), 2017; Wiek et al., 2011). Data were analyzed using thematic analysis through the stages of familiarization, open coding, categorization, and theme extraction (Braun & Clarke, 2021). To ensure data validity, this study applied source and method triangulation, member checking, and audit trails to meet the criteria of trustworthiness in qualitative research (Lincoln & Guba, 1985; Nowell et al., 2017). All research procedures were carried out in accordance with the principles of educational research ethics, including

informed consent and protection of participant confidentiality (Abdallah, 2024).

## C. RESULT AND DISCUSSION

### 1. Result

#### **The Importance of Integrating Local Culture into Science Education in Elementary Schools**

This subchapter presents the research findings regarding the actual conditions of local cultural integration in science education in the fourth grade of SDN 1 Bojong. The findings were obtained through interviews, classroom observations, and analysis of teaching modules used by teachers.

The interview results revealed that teachers had attempted to relate science learning materials to local cultural elements, such as cassava, bamboo, and traditional foods as contextual examples. However, this integration remained incidental and spontaneous rather than systematically planned within structured learning designs. As one teacher stated, *"I sometimes relate the lesson to things around students, like cassava or traditional foods, but it is not written in the module, so it depends on the situation in class."* Teachers also emphasized the absence of structured teaching resources, as reflected in the statement, *"There is no specific module that integrates local culture, so we usually rely on textbooks and add examples ourselves."*

Document analysis of the teaching modules indicated that cultural contexts appeared only as supporting illustrations rather than forming the main learning framework. Classroom observations further showed that science learning activities were still dominated by textbook use and teacher verbal explanations. Consequently, opportunities for students to construct scientific understanding based on their contextual and cultural experiences were not optimally facilitated. This was also reflected in students' responses, such as *"We usually follow what is in the book, and sometimes the teacher gives examples, but we rarely try things related to our daily life."*

In addition, the study identified the practice of making Garut dodol as a local cultural activity with strong potential for integration into science learning. The production process involves scientific concepts such as changes of matter, heat transfer, and physical and chemical transformations that align with the elementary science curriculum. This potential was recognized by participants, as one student mentioned, *"Making dodol is interesting because we can see how the ingredients change when heated,"* while the teacher added, *"Actually, the dodol-making process can be used to explain science concepts, but we have not developed it into a lesson yet."* The practice also reflects sustainability values, including the use of local resources, collaborative work, and community economic resilience.

Based on the collected data, the study formulated the need to develop an Ethno-ESD-based teaching module that positions local culture as the primary context of learning rather than merely as a supplementary example. The module is designed to explicitly integrate scientific concepts with sustainability values, enabling students to understand science within relevant environmental, social, and economic contexts. In addition, it aims to promote active student engagement through meaningful learning activities that encourage participation, exploration, and the development of creative thinking skills. Through this approach, science learning is expected to become more contextual, participatory, and oriented toward sustainable understanding.

#### **The Necessity of Incorporating Values from Education for Sustainable Development (ESD) into Science Lesson Plans**

This subchapter presents research findings related to the integration of Education for Sustainable Development (ESD) values in science learning in Grade IV at SDN 1 Bojong. The findings were derived from interviews, classroom observations, and document

analysis of teaching modules used by teachers.

Interview results indicated that teachers possessed normative awareness regarding the importance of fostering environmental responsibility among students, such as encouraging cleanliness and energy conservation. However, these sustainability values had not yet been systematically integrated into science lesson planning. As one teacher stated, *“We always remind students to keep the classroom clean and save energy, but it is not specifically written in the lesson plan.”* Another teacher added, *“Sustainability is important, but we usually just mention it briefly, not as part of the main learning objectives.”*

Document analysis revealed that learning indicators predominantly emphasized cognitive achievement, while sustainability competency dimensions such as systems thinking, reflective thinking, collaboration, and anticipatory thinking were not explicitly incorporated. Classroom observations further showed that discussions related to environmental impacts or socio-economic interrelationships were rarely developed into exploratory learning activities that encouraged students' critical analysis. This condition was also reflected in students' experiences, as one student mentioned, *“We learn about science concepts, but we rarely discuss how they affect the environment or daily life.”*

In addition, the study identified the local practice of making Garut dodol as having strong potential for integrating ESD values into science learning. The production process involves the use of local natural resources, energy consumption during heating, and family-based economic activities, reflecting the interconnection between environmental, social, and economic dimensions. This potential was acknowledged by participants, as one teacher explained, *“The process of making dodol actually involves many aspects of sustainability, such as using local ingredients and working together, but we*

*have not integrated it into learning yet.”* Similarly, a student expressed, *“If we learn through real activities like making dodol, it would be easier to understand and more interesting.”*

Based on the collected data, the study formulated the need to develop teaching modules that explicitly integrate ESD competencies into science learning structures. The proposed module should include contextual problem-based activities related to local sustainability issues, reflective questions that stimulate systemic and anticipatory thinking, and collaborative learning tasks that promote social awareness and environmental responsibility.

### **Developing Creative Thinking in Ethno-ESD-Based Science Education**

This subchapter presents research findings related to the need to develop students' creative thinking through Ethno-ESD-based science learning in Grade IV at SDN 1 Bojong. The findings describe the actual learning conditions, opportunities for creativity development through local cultural contexts, and the formulation of teaching module design requirements.

Classroom observations indicated that science learning was still predominantly conducted using an expository approach, with activities mainly focused on conceptual understanding and solving closed-ended questions. Although teachers occasionally provided contextual examples, these examples were not designed as exploratory learning activities that allowed students to generate new ideas, alternative solutions, or personal interpretations.

Interviews with students revealed that they showed higher interest and engagement when learning activities were connected to real-life practices, such as the process of making traditional foods. However, opportunities for students to discuss, redesign, or modify these processes were still limited. As a result, the potential of local cultural practices as a stimulus for creativity development had not been optimally utilized.

The study also identified the production process of Garut dodol as having strong potential to support creativity-oriented science learning. Activities such as temperature regulation, ingredient selection, and continuous stirring provide opportunities for problem-based exploration aligned with scientific concepts.

Based on data analysis, the study formulated the need for teaching module designs that integrate:

- (1) exploratory activities based on contextual local cultural issues;
- (2) reflective spaces that encourage flexibility and originality of ideas; and
- (3) collaborative projects aimed at developing simple sustainable solutions appropriate to elementary school students' developmental levels.

Conceptually, the Ethno-ESD model developed in this study positions local culture as the contextual trigger, science concepts as the scientific core, and sustainable creativity as the expected learning outcome.

## 2. Discussion

### The Importance of Integrating Local Culture into Science Education in Elementary Schools

The findings reveal a significant gap between the potential of local culture as a meaningful learning resource and its actual implementation in classroom science learning. The limited and incidental integration observed indicates that local knowledge has not yet functioned as an epistemological foundation for science instruction. From an ethnoscience perspective, science learning should bridge scientific knowledge with local cultural knowledge to construct contextual and meaningful understanding (G. S. Aikenhead, 1997; G. S. Aikenhead & Elliott, 2010; Zidny et al., 2020). However, current practices position culture merely as a supplementary illustration, which constrains students' opportunities to connect scientific concepts with their lived experiences. This condition reflects a

misalignment with constructivist learning theory, which emphasizes that knowledge is actively constructed through relevant experiences (Fosnot, 2013), resulting in science learning that tends to be abstract and disconnected from students' social realities.

Furthermore, within the framework of Education for Sustainable Development (ESD), science education is expected not only to transmit scientific knowledge but also to cultivate sustainability competencies grounded in real environmental, social, and economic contexts (UNESCO, 2017; Wiek et al., 2011). However, the findings indicate that these dimensions remain under-integrated in instructional practices. While previous studies have examined ethnoscience and ESD separately focusing either on cultural relevance or sustainability competencies this study offers a novel contribution by systematically integrating both into a unified pedagogical model (Ethno-ESD). The practice of Garut dodol production illustrates how cultural activities can simultaneously embed scientific concepts, cultural values, and sustainability dimensions within a single contextual framework, thereby providing a concrete basis for integrative learning design.

The novelty of this study lies in positioning local culture not merely as contextual support but as the primary epistemic entry point that structures the learning process, while aligning it with sustainability competencies and creative thinking outcomes. This has direct implications for classroom practice, requiring a shift from textbook-centered instruction toward context-driven inquiry. Teachers are encouraged to design problem-based learning activities rooted in local cultural practices, incorporate reflective questions that link science concepts to sustainability issues, and facilitate collaborative tasks that promote creative and critical thinking. Therefore, the development of an Ethno-ESD-based teaching module represents not only a pedagogical innovation but also an

epistemological shift toward more contextual, integrative, and transformative science learning in elementary education.

### **The Necessity of Incorporating Values from Education for Sustainable Development (ESD) into Science Lesson Plans**

The findings demonstrate a clear gap between the global urgency of Education for Sustainable Development (ESD) and its practical implementation at the elementary school level. Although teachers show general awareness of environmental values, such as promoting cleanliness and energy conservation, these remain implicit and are not translated into structured pedagogical strategies. As a result, sustainability education is not systematically embedded in lesson planning or classroom activities. According to UNESCO (2020), education should foster transformative competencies that enable learners to respond to sustainability challenges in a systemic manner, including systems thinking, anticipatory, normative, and strategic competencies (Anggraeni, 2024; Caniglia et al., 2016; Corres et al., 2020; Engle et al., 2017; Redman & Wiek, 2021). However, the absence of explicit integration of these competencies in science learning leads to fragmented understanding, where students master concepts without recognizing their relevance to real-world sustainability issues.

This condition indicates that current practices remain at the level of content transmission rather than pedagogical transformation. While previous studies have emphasized the importance of ESD, many still focus on adding sustainability-related content without fundamentally restructuring the learning process (Anggraeni, 2023; Burns, 2018). In contrast, this study highlights that the core issue lies in the lack of alignment between sustainability competencies and instructional design. The novelty of this study, therefore, lies in identifying the need to reposition ESD not merely as supplementary material but as a central organizing principle in science learning,

integrated through culturally relevant contexts. The use of local practices, such as the making of Garut dodol, provides a concrete analytical example of how environmental, social, and economic dimensions can be interconnected within a single learning activity, rather than being taught as separate or abstract concepts (Findler et al., 2019; Mebratu, 1998; Sherren, 2008; Wu, 2012).

From a practical perspective, this finding implies a necessary shift in classroom implementation. Teachers need to move beyond textbook-centered instruction by designing learning activities that explicitly incorporate sustainability competencies into each stage of the lesson (Anggraeni, 2024b; Berchin et al., 2021; Zhang, 2021). For instance, systems thinking can be developed by analyzing the resource flow in dodol production, anticipatory thinking through discussing the environmental impact of production processes, and reflective thinking through evaluating alternative sustainable practices. This structured integration represents a key contribution of the study, as it offers a concrete pedagogical pathway for operationalizing ESD in elementary science classrooms. Therefore, integrating ESD into science teaching modules should not be treated as an additional component, but as a central pedagogical orientation that enables contextual, transformative, and sustainability-oriented learning.

### **Developing Creative Thinking in Ethno-ESD-Based Science Education**

The findings indicate that current science learning practices have not yet fully supported the development of students' creative thinking skills. The dominance of teacher-centered and concept-oriented instruction limits opportunities for students to engage in idea generation, experimentation, and innovation processes.

From a theoretical perspective, creative thinking in science education involves the ability to produce original, flexible, and elaborated ideas in problem-solving situations (OECD, 2022). Within 21st-

century learning frameworks, creativity functions as an essential cognitive competence that supports innovation and complex problem solving (Beghetto & Kaufman, 2014). Therefore, creativity development should be intentionally embedded within learning design rather than emerging incidentally.

In the context of Education for Sustainable Development, creativity extends beyond cognitive originality toward transformative creativity the capacity to design alternative solutions to environmental and social challenges (Redman & Wiek, 2021; Wals & Benavot, 2017). This perspective emphasizes that science learning should connect conceptual understanding with sustainability realities experienced by students.

The integration of Ethno-ESD through local practices such as Garut dodol production demonstrates how culturally grounded contexts can create meaningful opportunities for creativity development. Problem-based activities related to energy efficiency, resource use, or environmentally friendly packaging enable students to connect scientific reasoning with contextual innovation. Previous studies have shown that authentic, real-world learning contexts significantly enhance creativity and higher-order thinking skills (OECD, 2022).

Furthermore, creativity within the ESD framework requires reflection on values and social responsibility (UNESCO, 2020). Linking local cultural practices with sustainability issues encourages students not only to understand science concepts but also to reconsider practices and propose more sustainable alternatives. This aligns with transformative learning theory, which emphasizes changes in ways of thinking and acting toward sustainability (Wals, 2022).

Thus, the development of Ethno-ESD-based teaching modules responds not only to the need for cultural and sustainability integration but also serves as a pedagogical strategy to strengthen students' creative competencies in addressing future sustainability challenges.

#### D. CONCLUSION

This study concludes that the This study concludes that the fundamental problem in elementary school science education is not the absence of local cultural potential as a learning resource, but rather the lack of its structured integration into a systematic, reflective, and sustainability-oriented pedagogical design. The findings show that although teachers have attempted to relate science material to local cultural practices, such integration remains incidental and has not yet developed into an epistemological framework for learning. Furthermore, the values of Education for Sustainable Development (ESD) have not been explicitly incorporated into teaching modules, resulting in learning that predominantly emphasizes cognitive achievement without fostering systemic, anticipatory, reflective, and creative thinking competencies. Based on these findings, this study proposes a conceptual model of an Ethno-ESD-based teaching module that positions local culture as the triggering context, science concepts as the scientific core, and sustainability and creativity competencies as the primary learning orientation. This model not only confirms the importance of ethnoscience in science education but also extends it by integrating ESD and creativity into a unified pedagogical framework. Practically, this model can be directly implemented by teachers through the development of contextual learning modules that begin with local cultural practices-such as the process of making Garut dodol-followed by guided scientific inquiry, reflective questions on sustainability issues, and collaborative tasks that encourage students to generate simple and creative solutions. Theoretically, this study strengthens and expands the integrative framework of ethnoscience and ESD at the elementary school level, while practically providing a foundation for developing contextual and transformative science learning. However, given that this study is limited to a qualitative case study context, further research is recommended to test the

effectiveness of Ethno-ESD-based modules through experimental or mixed-method approaches, to examine their impact on students' creative thinking and sustainability competencies, and to explore their implementation across broader educational settings.

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