

Potential of Madura Island's Local Wisdom as a Contextual Learning Resources for Chemistry Concepts in Junior Secondary Science Education

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Abstract

Madura Island possesses a diverse range of local wisdom with great potential to support contextual science learning. However, its integration into junior high school science education remains limited. This study aims to examine the potential of Madura Island's local wisdom as a contextual learning resource for chemistry concepts in junior high school science education. A literature review using a qualitative descriptive approach was conducted through the analysis of various peer-reviewed articles selected based on predetermined inclusion and exclusion criteria. The selected studies were synthesized using thematic analysis to identify forms of local wisdom, related chemistry concepts, and their alignment with the Learning Outcomes (CP) of the Merdeka Curriculum. The findings indicate that traditional herbal medicine, traditional foods, keris craftsmanship, salt production, and batik making encompass chemical concepts, including matter and its changes, pure substances, mixtures, elements, compounds, food additives, and chemical reactions. Previous research has also shown that learning materials based on Maduran local wisdom have high validity and reliability and receive positive feedback from students. Therefore, integrating local wisdom into science education at the junior high school level provides meaningful contextual learning while supporting the implementation of the Merdeka Curriculum and strengthening students' science literacy and conceptual understanding.

Keywords: Local Wisdom, Chemistry Concepts, Teaching Materials, Madura Island

INTRODUCTION

Every country has its own unique characteristics and local wisdom (Jaya et al., 2024). Indonesia is a country rich in natural resources as well as cultural heritage; it is undeniable that Indonesia is known worldwide as a multicultural nation, given its diversity in ethnicity, religion, culture, race, language, and so on (Widiatmaka, 2022). The local wisdom possessed by each country forms its identity, as local wisdom is cultural knowledge related to social etiquette. Thus, it can be preserved and sustained if it is beneficial and becomes the true identity of the community, which ultimately shapes the identity of the region itself (Danuwidjojo et al., 2021). Indonesia is one of the countries with a wealth of local wisdom. In addition, Indonesia consists of thirty-eight provinces, each with its own diverse local traditions, one of these is Madura Island, located in East Java. The local traditions of Madura Island exhibit distinct variations across each regency, a result of the fact that much of the island's culture was influenced by the kingdoms that existed in the past.

Madura Island consists of four regencies, Bangkalan, Sampang, Pamekasan, and Sumenep. Each regency possesses a wealth of distinctive local wisdom, with these socio-

cultural characteristics being more unique than those of other regencies and cities in East Java in general (Kutsiyah et al., 2022). This abundance of local wisdom holds potential as a supportive tool for learning, such as in chemistry lessons based on local wisdom. Furthermore, according to Annisha (2024), integrating local wisdom into learning is an effort to preserve values such as traditions, culture, and the natural or environmental characteristics of a region. Additionally, local wisdom contains values that can serve as a means of shaping national character, making it a suitable approach in the face of globalization (Anzelina, 2023). This is because every region possesses its own set of values that have become local wisdom and have been passed down from generation to generation.

Learning based on local wisdom is part of the efforts teachers can make to deliver instruction using a contextual approach (Risidiana et al., 2025; Mubarak et al., 2025; Hikmawati et al., 2025). A contextual approach is a learning approach that plans instruction by emphasizing meaningful learning, where utilizing multi-sourced learning materials related to the socio-context of the community is a strategic choice for achieving the goals of multicultural education and discovery-based learning (Romli, 2022). The connection between learning and the students' immediate environment is a hallmark of the contextual learning approach, thereby emphasizing that students are given the opportunity to actively participate in making learning engaging and meaningful (Suryawati & Osman, 2018; Mubarak et al., 2026). According to Fitria et al. (2025), explains that the contextual approach is fundamentally rooted in the constructivist approach, namely the process of integrating new knowledge about the environment into students' cognitive frameworks through experience. This is because knowledge stems from direct experience and contexts constructed by the students themselves, rather than by the teacher.

Learning that integrates local culture into science education can help improve scientific learning skills such as problem-solving, enhance students' knowledge, and foster socio-cultural values (Mubarak et al., 2026; Febrian et al. 2024). According to Kamila et al. (2024), this approach is used because many students perceive science instruction as being delivered in a way that is unengaging and irrelevant to their daily lives and socio-cultural backgrounds. This is supported by the statement from Ramli et al. (2025), that integrating local potential can enhance cultural awareness and respect for diverse perspectives, thereby creating a more inclusive learning environment. Furthermore, 21st-century learning requires students to possess scientific learning skills, aimed at solving complex problems through brainstorming, creative thinking, engaging in learning activities, and developing conceptual understanding of knowledge (Fitrah et al., 2022; Pribadi et al., 2022). This contextual learning will enable children to gain meaningful learning experiences through direct engagement. Consequently, it can facilitate access to knowledge for students and educators in conducting learning activities.

The purpose of this study is to examine the potential of Madura Island's local wisdom as a contextual learning resource for chemistry concepts in junior high school science education. Specifically, this study aims to identify chemistry-related concepts contained in various forms of Madura's local wisdom, analyze their alignment with the Learning Outcomes (CP) of the Merdeka Curriculum, and synthesize empirical evidence regarding their implementation as contextual learning resources. It is hoped that the findings of this study can serve as a reference for teachers, curriculum developers, and researchers in integrating local wisdom into junior high school science instruction to improve students' science literacy, conceptual understanding, and learning outcomes.

METHOD

This study employs a literature review using a descriptive qualitative approach. A literature review is a research method that systematically identifies, evaluates, and synthesizes

previous studies relevant to a specific research topic (Snyder, 2019; Creswell & Creswell, 2018). According to Chigbu et al. (2023), a literature review does not merely focus on collecting scientific publications but also aims to establish a theoretical foundation and identify research developments and trends. Therefore, this study employs qualitative descriptive analysis so that findings from various sources of literature can be interpreted inductively and synthesized into comprehensive conclusions based on the available evidence (Lim, 2025).

The literature review was conducted systematically by adopting the principles proposed by Kitchenham et al. (2015). Relevant articles were identified, screened, evaluated, and synthesized based on predetermined inclusion and exclusion criteria. The literature search was conducted through the Google Scholar, Scopus, and SINTA databases using the keyword combination “Madura local wisdom” AND “ethnoscience” AND “science learning” AND “chemical concepts” AND “secondary school.” The inclusion criteria consisted of: (1) peer-reviewed journal articles published between 2015 and 2025; (2) studies discussing Maduran local wisdom or ethnoscience; (3) studies related to the teaching of chemistry concepts at the junior high school level; and (4) articles available in full text. Exclusion criteria included duplicate publications, book chapters, review articles, and studies unrelated to science education or contextual learning.

All selected articles were then analyzed using qualitative thematic analysis from Braun & Clarke (2006) to identify recurring themes regarding the types of Madurese local wisdom, the chemical concepts contained therein, and the potential for their integration into the learning outcomes (CP) of the M

erdeka Curriculum for junior high school science. The analysis focused not only on identifying the chemical concepts found in various forms of Madurese local wisdom but also on examining their relevance as contextual learning resources. In addition, this study synthesized empirical evidence related to the development of instructional media, the validity of the media, student responses, science literacy, and learning outcomes.



Figure 1. Research process stages

RESULT AND DISCUSSION

Local Wisdom

Local wisdom refers to the values, norms, and social practices that have naturally evolved within a community. This reflects a community’s perspective on protecting the environment, managing daily life, and building economic relationships that are in harmony with their own local culture (Shambono et al., 2025). Furthermore, local wisdom is understood as the cultural heritage of the past that serves as a guiding principle for a community’s way of life, where this local wisdom constitutes local knowledge or indigenous knowledge that has developed within the region itself (Yasir, 2023). According to Annisha (2024), another meaning of local wisdom is that it functions as a way of life that develops within a specific social and ethnic group shaped by unique natural, geographical, and historical experiences. Thus, the values of local wisdom are not viewed as two conflicting entities, but rather as elements that form the identity of a cultural community.

Local wisdom possesses distinctive characteristics and functions that are vital to communities in a specific region, including serving as a cultural identity, acting as a unifying element within the community in a social context, evolving naturally as a cultural element, and fostering a sense of togetherness within a particular culture. Furthermore, local wisdom can

foster shared understanding among individuals and groups in communication, and can promote solidarity, mutual respect, and collective mechanisms to defend against potential disruptions or threats to community solidarity as a cohesive whole (Rohmadi, 2022). Thus, the identity of local wisdom becomes a unique strength in preserving the cultural values it contains for the character development of the community members themselves.

Integrating Local Wisdom into the Learning Process

Concept of the Merdeka Curriculum is to return the national education system to the essence of the law by granting schools flexibility in achieving the Learning Outcomes through contextual learning experiences (Kamila et al., 2024), so that the implementation of the Merdeka Curriculum can become more relevant and interactive, where project-based learning will provide students with ample opportunities to actively explore factual issues in their communities. This aligns with the statement by Tuerah & Tuerah (2023), who note that the implementation of Merdeka Belajar focuses more on responsive, inclusive, and student-centered learning tailored to 21st-century competencies, such as problem-solving, creativity, communication, and collaboration for all of which are inseparable from the use of technology in learning activities. Therefore, the Merdeka Curriculum is based on a learning approach that tends to be contextual and student-centered to accommodate the potential needs of individual students and provide space for students to actively and creatively participate in applying relevant concepts in daily life, such as local wisdom.

Integration of local wisdom into learning is inspired by the Merdeka Curriculum. According to Amaliyah et al. (2023) and Torro et al. (2021), the implementation of the Merdeka Curriculum where learning is based on local wisdom is an approach that integrates cultural values, traditions, and local wisdom into the learning process, thereby enabling students to understand and appreciate their cultural heritage and increasing their engagement in a more contextual learning process. This is because this approach acknowledges the richness and uniqueness of the culture and traditions present in the local community and integrates them into the curriculum and learning strategies (Drani & Susanti, 2022). According to Shufa (2018), the integration of local wisdom into the learning process within the Merdeka Belajar Curriculum concept can be implemented through several strategic stages, including identifying the conditions and potential of the region, defining the functions and objectives of learning, determining the criteria and materials to be studied, and designing learning activities based on local wisdom. Thus, this integration is expected to be effective and have a positive impact on student learning by fostering a sense of pride in their own culture and identity, aligned with the concept of chemistry.

Integration of local wisdom values into the Merdeka Belajar Curriculum framework does not focus solely on efforts to preserve local culture and traditions, but also aims to strengthen students' educational foundation in various aspects of life. This aligns with the statement by Amaliyah et al. (2023), that the implementation of a local wisdom-based learning approach provides students with the opportunity to actively engage in the learning process through discussion, exploration, and the application of concepts in real-world contexts. However, there are several limitations to this integration, as explained by Sumartini et al. (2025), such as teachers' lack of understanding of local values and how to relate them to the curriculum. Additionally, limited learning time, the absence of clear guidelines, and a shortage of appropriate teaching materials and resources also pose barriers, while the lack of teacher training further exacerbates these challenges. Therefore, a structured and ongoing evaluation is needed to help teachers identify successes, challenges, and opportunities in the implementation process. Consequently, learning will be richer, more relevant, and meaningful

for students, helping them grow into individuals of character, knowledge, and competitiveness in the era of globalization.

Essence of Chemistry Learning Based on Local Wisdom

Learning concepts in chemistry are predominantly abstract in nature, as evidenced by the various concepts found in chemistry materials, such as changes in matter at the atomic and molecular levels and the use of symbols and formulas, making them difficult for students to understand (Indriani et al., 2023). Therefore, teachers need to seek learning methods that can enhance students' conceptual understanding, one of which is through the use of learning approaches based on local wisdom. This is supported by Widodo (2020), statement that learning with a local wisdom approach enables more contextual learning, which is beneficial for explaining various concepts considered abstract. This is also supported by Priliyanti et al. (2021), who note that chemistry is one of the fields of study disliked by students, as it is perceived as a subject with abstract, difficult, and boring concepts by most students. This is why students lack motivation to study chemistry. According to Noviana et al. (2023), research based on local wisdom is a nature conservation strategy grounded in community knowledge, values, and ancestral history to foster a sense of community and local wisdom. Thus, integrating local wisdom into science education such as chemistry is expected to shape students' character and enhance their contextual understanding of science.

Local Wisdom on Madura Island as a Source of Chemistry Concepts

Local wisdom is defined as the values that prevail in a community, the validity of which serves as a guide for daily behavior. According to Sakti et al. (2024), integrating local wisdom into learning is an important initiative aimed at fostering cultural identity and awareness. Local wisdom can be implemented in both tangible and intangible forms, such as language, literature, art, ceremonies, customs, traditions, and others (Nur et al., 2024). Local wisdom is categorized into five types: food, medicine, production techniques, home industries, and clothing. In the cultural sphere, local wisdom is not limited to physical aspects but also encompasses broader elements such as traditional ceremonies, cultural heritage sites, nature tourism, traditional transportation, traditional games, cultural facilities, traditional attire, museums, cultural institutions, the arts, traditional villages, handicrafts, folk tales, children's games, and wayang. According to Balisosa et al. (2020), the core values of local wisdom include love for God and nature, responsibility and honesty, respect and compassion, hard work and self-confidence, as well as upholding justice, humility, tolerance, peace, and unity.

The selected studies reveal several forms of Madura local wisdom that have the potential to serve as contextual learning resources in junior high school science education. For clarity, these findings are presented in thematic categories based on the type of local wisdom, followed by an analysis of the related chemical concepts and their educational implications.

Traditional Herbal Medicine

People of Madura have long been familiar with and used Jamu to address health issues, even before the widespread use of synthetic drugs. Drawing on local wisdom passed down through generations from their ancestors, they use various plants to alleviate symptoms and treat a wide range of illnesses. Some examples of Madurese Herbal Medicine include Keraton Sumenep Herbal Medicine, Sarkoyo, Bangkes, and Sinom. According to Sudarmin & Asyhar, (2012), there are many scientific concepts involved in the preparation and formulation of Jamu, as well as the chemical compounds found in its ingredients and their health benefits, making it a valuable resource for contextual learning.

Sumenep Royal Herbal Remedies (*Jamu Keraton*) are traditional herbal recipes from the Sumenep Royal Palace that have been passed down through generations by the palace nobility. Based on a study by Putri et al. (2022), it was revealed that local community knowledge can

be integrated into science education; it is known that traditional royal herbal remedies, whether in the form of herbal drinks or body scrubs, are related to science concepts such as mixtures and pure substances, as well as containing natural chemical compounds beneficial to health. This connection can be aligned with the Learning Outcomes (CP) for Junior Secondary Science, particularly within the Science Understanding element concerning matter and its changes, including mixtures, pure substances, elements, compounds, and their physical and chemical properties in everyday life. Additionally, based on findings by Mubarak et al. (2025), *Sarkoyo* is a traditional herbal remedy that has been used by the Madurese community for years, typically made from coconut milk, eggs, ginger, sugar, and cloves; this remedy is believed to help maintain health. The study revealed that the process of making *Sarkoyo* involves various science concepts such as mixtures and pure substances, as well as the nutritional content of the ingredients, which are relevant to the Learning Outcomes for Junior Secondary Science. These concepts can be integrated into the Science Understanding element, particularly the Learning Outcomes related to matter and its changes, including mixtures, pure substances, and food additives as encountered in everyday life. Additionally, there is also a herbal formula for Sono' Cows, as described in the ethnobotanical study by Amelia et al. (2024), which suggests that the herbal medicine commonly used for Sono' Cow can be integrated into science education covering chemistry concepts such as biochemistry, as well as pure substances and mixtures.

There are also several Madurese herbal remedies that are still commonly found today, namely *Bangkes* and *Sinom* herbal medicine. According to Putri et al. (2024), *Bangkes* is an herbal remedy used to relieve headaches and as an antidepressant. Meanwhile, *Sinom* is an herbal remedy or beverage made from young tamarind leaves with added granulated sugar or palm sugar (Yuliati et al., 2022). Both of these herbal remedies are related to science concepts such as mixtures, pure substances, and additives. These concepts are aligned with the Learning Outcomes of the Merdeka Curriculum, particularly within the Science Understanding element, which covers matter and its changes, including mixtures, pure substances, and food additives in everyday contexts.

Traditional Food

Cultural diversity on Madura Island has become a defining characteristic of each region, as evidenced by the variety of local dishes found in every regency on the island. According to research by Hidayat et al. (2024), fish salting by the community of Sepanjang Village, Sumenep, is related to chemical concepts, including solutions and mixtures (dissolution of salt/NaCl in water), the processes of osmosis and plasmolysis in fish cells due to high salt concentration, as well as chemical reactions such as fat oxidation, which causes a distinctive odor, and the Maillard reaction, which causes a browning change in color during drying. These concepts are aligned with the Learning Outcomes for Junior Secondary Science, particularly within the Science Understanding element, which includes matter and its changes, solutions and mixtures, food additives, and their applications in everyday life. However, the discussion of these concepts is not limited to the junior high school level but can also be expanded at the senior high school level, such as solution equilibrium, reaction kinetics (oxidation), and food chemistry. Additionally, there is Terasi, a seafood product with unique characteristics depending on the region, particularly in terms of production processes, ingredients used, and flavor. According to a study by Hadi et al. (2019), the production process of rebon shrimp terasi is one of the local wisdom practices of the Madurese community that is closely linked to chemical concepts, including the concepts of matter (atoms, ions, molecules), mixtures and pure substances (elements and compounds), as well as food additives. Additionally, there is another seafood product, namely *petis*.

Petis is a food product with a semi-moist texture and a paste-like consistency made from meat, fish, or shrimp byproducts; it is commonly used as a seasoning and a dressing for fruit salad. According to Rahman et al. (2023), the Madura Petis Processing context-based Science module on the theme of mixture separation can be applied in contextual science learning following a feasibility test by subject matter experts, which yielded a very high average score of 89.17% and a reliability of 96.19%, categorized as highly reliable. This is also consistent with Nadifah et al. (2023), who found that the use of Magazine-style instructional media, such as Flipbook, received a positive response from students at 75.00% following a validity test with an average of 88.33% and 98.61% in the media sequence and concept aspects both categorized as highly valid along with reliability scores of 86.18% and 98.41%, classified as highly reliable. In addition, there are also several traditional foods commonly found in Madura, such as *Jhubada*, *Bakdabak*, *Campor Lorjuk*, *Kaldu Kokot*, and *Lala' Satay*, which can be integrated into science learning using the chemistry concepts of pure substances and mixtures.

Traditional Weapons

Traditional weapons are tools used by communities both for self-defense and to facilitate daily activities in earning a living. According to Maulidah & Purwanto (2024), each region has its own traditional weapons with distinct characteristics that serve as the identity and hallmark of that local community. This is also true of Madura Island, which has distinctive traditional weapons such as the keris. The Keris is a cultural heritage with high aesthetic value, and UNESCO has designated Sumenep as the region with the highest number of Keris craftsmen in the world, with the majority located in Aeng Tong Tong Village. Sumenep is nicknamed the “City of Keris,” home to over 600 active master craftsmen who create more than 2,000 Keris, distributed throughout the archipelago and even internationally (Mukhlisi & Fadli, 2024). According to a statement by Yasir & Hartiningsih (2023), Madurese keris can be linked to science concepts regarding elements, compounds, and mixtures, where the tools and materials used to make keris relate to the concepts of elements, compounds, and mixtures specifically, the process of coloring the keris blade relates to compounds, while separation methods for mixtures, such as filtration and precipitation, are also closely linked to the process of making the warangan solution. This is supported by research from Anjelina et al. (2025), which indicates that the use of an e-module based on the Madura keris context can enhance students’ science literacy regarding elements, compounds, and mixtures, where the pretest score was approximately 22.39; however, after participating in learning with the Madura keris context e-module, it increased to 77.22, with 16 students in the high category (53.33%) and 14 others in the moderate category (46.67%), as indicated by an n-gain value of 0.64. Thus, the integration of local wisdom, such as the Madura keris, into science learning on the topics of elements, compounds, and mixtures in the form of an e-module can improve students’ science literacy.

Salt Production

Madura Island has long been known as a salt-producing island, with the salt industry in Madura known to have begun in the 19th century. According to Widyanti & Setiyonugroho (2022), Madura Island was the main supplier of salt to the entire Dutch East Indies. However, to reach Batavia, the center of trade, salt from Sumenep had to be shipped to Surabaya. Furthermore, salt farmers still use traditional methods in salt processing. The knowledge they possess has been passed down through generations based on the local wisdom of the Maduran people. This local knowledge can be integrated into science education, as suggested by Hadi & Ahied (2017), who noted that the knowledge involved in making Maduran salt can be analyzed through scientific concepts, thereby serving as a learning resource for students. The relevance of these concepts is reflected in the material on mixtures and pure substances (elements and compounds), such as the names of compounds found in seawater and the salt crystallization process.

Batik Making

Batik is a form of local wisdom found across various regions, each with characteristics specific to its place of origin. According to Izzah et al. (2020), hand-drawn *batik* can be linked to science concepts such as chemistry specifically topics like elements, compounds, mixtures, acids and bases, and solubility which can be identified in the batik-making process. This aligns with research by Hadi et al. (2026), which found that the use of a Maduran hand-drawn batik-themed magazine specifically the *Ghentongan Tanjung Bumi* led to improved science literacy among students. Pre-test scores averaged 54.81, but post-test scores reached 82.67 after learning with this medium, yielding an N-Gain of approximately 0.63 a value considered moderate. This is also supported by observations conducted by Afrida et al. (2025) who used a magazine featuring Madura hand-drawn batik, suggesting that the more engaging the instructional materials used, the more enthusiastic students become in participating in the learning process.

CONCLUSION

Madura Island possesses a wealth of local wisdom that holds great potential to be used as contextual learning resources for chemistry concepts in junior secondary science education. This study confirms that various forms of local wisdom are not merely cultural heritage but also a rich source of chemistry-related concepts directly relevant to the Learning Outcomes (CP) of Junior Secondary Science. These local wisdom practices can be mapped to the Learning Outcomes (CP) of the Merdeka Curriculum, particularly within the Science Understanding element, covering concepts such as matter and its changes, mixtures, elements, compounds, food additives, and chemical reactions. Furthermore, the integration of Maduran local wisdom into junior secondary science learning through chemistry concepts aligns with the spirit of the Merdeka Curriculum, which promotes contextual, student-centered, and culturally responsive pedagogy. This is achieved by connecting abstract chemical concepts to socio-cultural practices that are familiar in students' daily lives. The development of learning media such as electronic modules, integrated science modules, and ethno-science themed magazines based on Maduran local wisdom has demonstrated high validity and reliability as well as positive responses from students, thereby strengthening the practical application of this approach in the classroom setting. Nevertheless, several challenges exist, including limitations in teachers' competencies regarding ethno-science or local wisdom-based instruction, the absence of structured guidelines, and a lack of available instructional materials. Therefore, it is recommended that future research focus on developing a comprehensive and systematic framework for designing contextual science teaching materials based on local wisdom, as well as conducting experimental or quasi-experimental studies to directly measure the impact of these teaching materials on student learning outcomes, higher-order thinking skills, and cultural identity.

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