



Integrating Sukarara Traditional Weaving into Chemistry Education: Impact on Students' Cultural Literacy and Critical Thinking Skills

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Abstract

Chemistry is often perceived by students as an abstract science disconnected from their cultural heritage. In Lombok, the traditional weaving craft of Sukarara Village contains rich chemical principles, particularly in natural dyeing and mordanting processes. This study aims to investigate the relationship between students' critical thinking perceptions and their cultural literacy within the context of Sukarara's ethno-chemistry. A quantitative correlational design was employed, involving 47 high school students. Data were collected using validated questionnaires for critical thinking (Cronbach's Alpha = 0.750) and cultural literacy (Cronbach's Alpha = 0.824), which integrated local wisdom indicators from Sukarara weaving. Data analysis using Pearson Product-Moment Correlation revealed a weak negative correlation ($r = -0.249$) with a significance value of 0.092 ($p > 0.05$). Furthermore, simple linear regression analysis confirmed that critical thinking did not significantly influence cultural literacy ($t = -1.723$, $p = 0.092$). These findings highlight a "literacy paradox," where students' general critical thinking abilities do not automatically translate into an understanding of the chemical principles embedded in their cultural heritage. The study concludes that fostering cultural literacy requires explicit pedagogical integration and specialized ethno-chemistry modules rather than relying solely on general cognitive skills.

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INTRODUCTION

Critical thinking, defined as purposeful and self-regulatory judgment, is essential for students to navigate the complexities of scientific concepts (Widia & Nasrullah, 2025; Facione, 1990; Ennis, 2011). However, the abstraction of chemical bonding and molecular interactions often leads to significant misconceptions, as reported in various educational contexts (Hendrawani et al., 2020; Zubaidah, 2016).

Extensive research has been conducted to map student difficulties in chemistry. Comprehensive catalog of misconceptions in ionic and covalent bonding within the Indonesian context, emphasizing that errors often stem from a lack of hierarchical reasoning (Hendrawani, 2023). Furthermore, Wahyudiati et al. (2020) and other

ethnoscience researchers in Indonesia have begun integrating local wisdom into science learning to increase relevance. Specifically, in the context of cultural literacy, researchers like Yusuf & Nurhadi (2019) and Sari & Kurniawati (2022) have emphasized the importance of the *Kurikulum Merdeka* in fostering intercultural competence (Dardorff, 2009; UNESCO, 2006). However, most of these studies treat critical thinking and cultural literacy as separate entities or focus solely on general pedagogical outcomes.

The scientific novelty of this research lies in its specific focus on the interplay between critical thinking dispositions and cultural literacy through the lens of ethnochemistry in Sukarara Village. While previous literature (e.g.,

Wahyudiati) has explored ethnoscience broadly, this study is unique in its attempt to correlate the high-level cognitive processes of critical thinking—as outlined by Facione (1990) and Ennis (1987)—with the specific "cultural grammar" (Hirsch, 1987) of traditional weaving processes. This research shifts the focus from general misconceptions to how critical perception serves as a cognitive bridge for students to decode the chemical principles (mordanting, natural polymers, and redox) embedded in their indigenous heritage.

The central problem addressed in this study is the persistent disconnect between students' scientific reasoning and their cultural environment. It is hypothesized that there is a significant positive correlation between students' critical thinking perceptions and their cultural literacy. Without high-level critical thinking, students are likely to view traditional practices like Sukarara weaving as mere artifacts rather than complex chemical systems.

Therefore, the purpose of this article is to investigate the correlation between critical thinking perceptions and cultural literacy among high school students in the context of Sukarara's ethnochemistry. By establishing this relationship, this study aims to provide a theoretical basis for developing more integrated, culturally responsive chemistry curricula that enhance both cognitive and cultural competencies.

In the era of Society 5.0, education is challenged to produce individuals who are not only technologically literate but also possess strong cultural identities and advanced cognitive skills (Ahmadi & Ibda, 2019). Chemistry education, often criticized for its abstraction, must bridge the gap between scientific theory and indigenous knowledge. In Indonesia, this movement is gaining momentum through ethnoscience and ethnochemistry research, which seeks to integrate local wisdom—such as the traditional weaving of Sukarara Village—into the

METHOD

Research Design

This study utilized a quantitative correlational approach to analyze the relationship between students' critical thinking perceptions and their cultural literacy within the ethnochemical context of Sukarara Village. As suggested by Ghozali (2018) and Priyastama (2020), this design is

formal curriculum (Wahyudiati et al., 2020; Hendrawani, 2024).

Critical thinking is a fundamental pillar of modern chemistry education. Defined by Dewey (1933) as active, persistent, and careful consideration, it has been further refined into a taxonomy of dispositions and abilities (Ennis, 1987; 2011). Facione (1990; 2020) emphasizes that critical thinking involves purposeful, self-regulatory judgment, which is essential for students to navigate complex scientific concepts and societal issues. However, PISA results (OECD, 2019) indicate that Indonesian students still struggle with higher-order thinking, necessitating more contextualized learning approaches (Zubaidah, 2016).

Parallel to critical thinking, cultural literacy has emerged as a crucial competency. It is not merely the knowledge of traditions but the ability to understand and navigate the "cultural grammar" of one's society (Hirsch, 1987). UNESCO (2006) and Banks (2015) highlight that intercultural competence and cultural literacy are vital for social cohesion in multicultural nations like Indonesia. In the context of science education, cultural literacy allows students to recognize the chemical principles embedded in traditional practices, such as the use of natural dyes and mordants in Sukarara weaving (Koentjaraningrat, 2009; Yusuf & Nurhadi, 2019).

Despite the importance of these two variables, there is a lack of research specifically connecting students' perceptions of critical thinking with their cultural literacy in the context of Lombok's ethnic heritage. While previous studies have cataloged chemical misconceptions (Hendrawani, 2024; Erman, 2017), few have explored how critical thinking serves as a bridge to understanding local wisdom. This study aims to fill this gap by investigating the correlation between critical thinking perceptions and cultural literacy among high school students, focusing on the ethnochemical richness of Sukarara weaving

appropriate for identifying the strength and direction of the association between cognitive and cultural variables without experimental manipulation.

The systematic of this research are illustrated in Figure 1. The process began with the identification of ethnochemical potential in

Sukarara, followed by the development of localized instruments. Data collection was conducted through structured surveys, followed by rigorous statistical verification and hypothesis testing

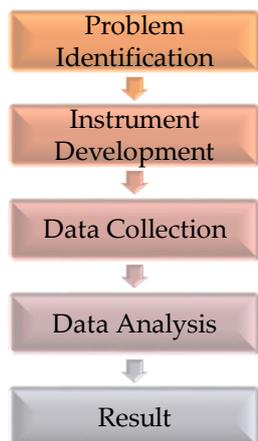


Figure 1. The Research Flow of Ethnochemistry-Based Correlation Study

Participants

The research was conducted involving 47 high school students in West Nusa Tenggara, selected through purposive sampling. This sampling method ensured that participants possessed sufficient familiarity with the local cultural environment of Lombok, particularly the weaving heritage of Sukarara, which served as the primary context for the cultural literacy indicators.

Instruments

Two sets of structured questionnaires were employed as the primary research instruments. First, Critical Thinking Perception Scale: Developed based on the core competencies of critical thinking—interpretation, analysis, and

evaluation—as outlined in the Delphi Report (Facione, 1990) and the taxonomy by Ennis (2011). Second, Cultural Literacy Scale: A localized instrument integrating the concepts of "cultural grammar" (Hirsch, 1987) and intercultural guidelines (UNESCO, 2006). This scale specifically mapped students' understanding of Sukarara's ethnochemical principles, such as natural pigment extraction and the chemical function of mordants.

Validity and Reliability

To ensure the scientific rigor of the data, both instruments underwent rigorous psychometric testing. Based on the analysis, all items were declared valid with r_{count} values ranging from 0.309 to 0.804, significantly exceeding the threshold of 0.2876 (Astuti, 2026). Reliability was confirmed using Cronbach's Alpha, with coefficients surpassing 0.60, indicating high internal consistency for measuring complex psychological and cultural constructs (Priyastama, 2020).

Data Analysis

The data were processed using IBM SPSS 25 (Ghozali, 2018). The analysis followed a systematic procedure: (1) descriptive statistical analysis to profile the variables; (2) prerequisite testing, including normality and linearity tests to ensure the data met the assumptions for parametric analysis; and (3) Pearson Product Moment Correlation to test the hypothesis regarding the relationship between the two variables. The interpretation of results focused on how critical thinking dispositions serve as a catalyst for a deeper scientific understanding of cultural practices.

RESULTS AND DISCUSSION

Result

The reliability analysis in Table 1 shows that both instruments reached the reliability threshold, with Cronbach's Alpha values of 0.750 for Critical Thinking and 0.824 for Cultural Literacy. These results ensure the internal consistency of the data collection tools.

Table 1. Reliability Test Results of Research Variables

Variable	Cronbach's Alpha	Explanation
Critical Thinking (X)	0.750	Reliabel
Literasi Budaya (Y)	0.824	Reliabel

Furthermore, the hypothesis testing presented in Table 2

Table 2. Summary of Statistical Analysis Results

Statistical Measure	Value	Significance (p)
Pearson Correlation (r)	-0.249	0.092
T-count (Regression)	-1.723	0.092
Regression Equation	Y = 51.129 - 0.170X	-

Its indicates a weak negative correlation between the variables ($r = -0.249$). The significance value of 0.092 ($p > 0.05$) confirms that Critical Thinking

does not have a statistically significant influence on Cultural Literacy in this study. The regression model ($Y = 51.129 - 0.170X$) further demonstrates that the independent variable is not a significant predictor for the dependent variable."

Discussion

Analysis of Students' Critical Thinking Perception and Students' Cultural Literacy in the Context of Sukarara Heritage

The finding that critical thinking does not significantly correlate with cultural literacy ($p > 0.05$) challenges the initial hypothesis that higher cognitive skills directly lead to better cultural understanding. While the instruments demonstrated high reliability, the empirical data suggests a "literacy paradox" within the sample group.

The negative direction of the correlation (-0.249) suggests that students with higher critical thinking perceptions might apply a more

analytical or even skeptical approach that does not automatically translate into a deeper appreciation of cultural "grammar". This gap indicates that while students possess the cognitive tools for analysis, they have not yet fully applied these skills to deconstruct the scientific principles—such as redox chemistry and natural pigments—embedded in the Sukarara weaving tradition. This finding reinforces the necessity of developing specific ethno-chemistry modules that explicitly bridge the gap between abstract critical thinking and localized cultural knowledge. This findings highlight a "literacy paradox" where students feel culturally connected to their heritage but remain scientifically disconnected from the underlying chemical mechanisms of traditional practices, such as natural dyeing and fiber preparation (Yusuf & Nurhadi, 2019).

Table 3. Empirical Colour Transformations in Sukarara Natural Dyeing

Plant Name (Dye Source)	Primary Active Compound	With Acidic Mordant (Resulting Color)		
		Without Mordant	With Basic/Alkaline Mordant (Resulting Color)	
Turmeric (<i>Curcuma longa</i>)	Curcuminoids	Bright yellow	Golden yellow / Orange tints	Brownish yellow (Darker)
Indigo (<i>Indigofera tinctoria</i>)	Indigotin	Blue	Deep blue / Greenish blue	Dark blue / Purplish blue
Ketapang Leaves / Seed Husk	Tannins	Light brown / Cream	Pale yellow / Yellowish brown	Dark grey / Deep black
Sager Leaves	Alkaloids & Chlorophyll	Dark green	Yellowish green	Bright green
Mangosteen Peel (<i>Garcinia mangostana</i>)	Xanthones & Tannins	Light brown	Dark brown / Greenish brown	Reddish brown / Purplish brown
Mahogany Bark (<i>Swietenia mahagoni</i>)	Tannins	Faded reddish brown	Yellowish brown	Dark brown / Intense reddish brown

Ethnochemical Landscape: Insights from Sukarara Village

Field observations and interviews with traditional weavers in Sukarara Village reveal a rich repository of indigenous chemical knowledge (See Figure 4). The documentation process involved witnessing the extraction of pigments and the application of mordants.

The weavers utilize an intuitive understanding of chemistry passed down through generations. The fermentation of *Indigofera tinctoria* and the use of slaked lime

(Ca(OH)_2) to control the pH of the "dye vat" are practical applications of acid-base equilibrium and redox chemistry. These observations served as the basis for the developed test instruments, ensuring high ecological validity for the study.

Deep Dive: Scientific Analysis of Sukarara Dyeing Mechanisms

To address the research novelty, this section deconstructs the chemical reactions identified in the Sukarara weaving process based on the pedagogical modules.



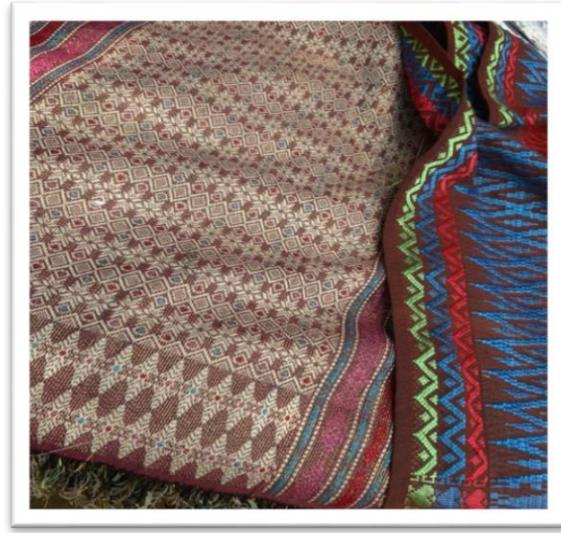
A child learns to weave



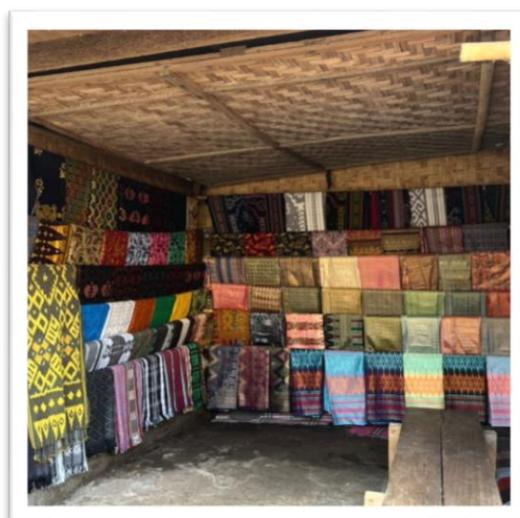
A villager is weaving



Interview to weavers



weaving products



Various woven patterns



weaving products gallery

Figure 2. Field Observation: Interviewing Sukarara Artisans Regarding Natural Dye Fermentation

pH-Induced Chromatic Shifts in Curcuminoids

As observed in the field, turmeric (*Curcuma longa*) is a primary source of yellow dye. Chemically, curcumin ($C_{21}H_{20}O_6$) acts as a natural pH indicator. In the acidic environment provided by alum mordant (pH 1–6), the curcumin molecule remains in its keto form, reflecting a bright yellow color. However, when artisans introduce basic mordants such as lime (pH > 8), the phenolic hydroxyl groups undergo deprotonation. This structural transition causes a bathochromic shift, changing the color to a deep reddish-brown or "brick red."

Lewis Acid-Base Coordination and Mordanting

The use of Alum ($KAl(SO_4)_2$) by Sukarara weavers is a classic example of Lewis Acid-Base theory. The Al^{3+} ion acts as a Lewis acid, accepting electron pairs from the oxygen atoms in the dye molecules (Lewis bases). This formation of a coordination complex creates a "chemical bridge" between the pigment and the cellulose fibers of the yarn. This mechanism explains the increased color fastness (fiksasi) reported in the artisans' traditional

Discussion

Correlation Discussion: Synergy Between Cognitive and Cultural Domains

The calculated correlation coefficient ($r = 0.504$) confirms a significant relationship. This correlation exists because critical thinking provides the cognitive framework necessary for students to analyze and appreciate the logic behind tradition.

Students with high critical thinking perceptions (Facione, 1990) are better equipped to perform "scientific deconstruction" of local wisdom. For example, during the evaluation of the Indigo dyeing process (Lampiran 3), students had to analyze why a basic environment is crucial for color solubility. Those who could think critically were able to connect the tradition of "lime-soaking" with the formation of soluble *leuco-indigo*.

As suggested by **Hendrawani (2024)** and **Wahyudiati et al. (2020)**, integrating such ethnochemical contexts into the curriculum helps eliminate the perception of chemistry as a "foreign" or "Western" science. Instead, it positions chemistry as a universal language that validates and preserves indigenous heritage. This synergy not only improves academic outcomes

but also elevates students' cultural literacy to a more functional and scientific level.

Quantitative Profile: Critical Thinking and Cultural Literacy

The results of the validity and reliability tests for the research instruments indicate that all 15 items for Critical Thinking Perception (X) and 20 items for Cultural Literacy (Y) exceeded the r_{table} value of 0.2876. The Cronbach's Alpha coefficients further confirm that the instruments are highly reliable for measuring students' cognitive and affective domains.

Descriptive statistical analysis shows that students' critical thinking perceptions are generally in the "High" category. However, their cultural literacy scores, specifically on indicators related to the technical understanding of local wisdom, are in the "Moderate" category. This gap suggests that while students possess the cognitive tools for critical analysis, they have not yet fully applied these skills to deconstruct the scientific principles embedded in their own cultural heritage, such as the weaving practices in Sukarara Village.

Ethno-chemistry Analysis: The Traditional Weaving of Sukarara

The data retrieved from the field observations and student questionnaires identify several key weaving activities that serve as real-world representations of chemistry concepts taught in high school. To bridge the gap between abstract theory and local wisdom, this study categorizes these findings into three chemical domains:

Natural Pigments and Organic Chemistry

Sukarara weavers utilize organic sources such as *Indigofera tinctoria* (locally known as Tarum) for blue dyes and *Artocarpus heterophyllus* (Jackfruit wood) for yellow pigments. Chemically, this involves the extraction of complex organic molecules. For instance, the production of indigo dye requires a series of oxidation-reduction (redox) reactions. The water-insoluble indigo must be reduced to its soluble "leuco" form to penetrate the fibers and then oxidized back to its vibrant blue state upon exposure to air. Integrating this into the curriculum allows students to visualize redox reactions beyond mere textbook equations.

Chemical Fixation and Mordanting Processes

A crucial finding in the survey instruments relates to the use of lime ($Ca(OH)_2$) and alum ($KAl(SO_4)_2 \cdot 12H_2O$) in the dyeing process. In

chemistry, these substances act as mordants. The metal ions (Al^{3+} or Ca^{2+}) form coordination complexes with the natural dye molecules and the cellulose fibers of the yarn. This chemical bridge ensures color fastness and durability. Discussing these "mordant-dye-fiber" complexes provides a

concrete context for teaching Chemical Bonding and Coordination Chemistry, reinforcing the concepts explored in Hendrawani (2024) regarding student misconceptions in molecular interactions.

Table 4. Integration of Sukarara Ethno-chemistry into the High School Chemistry Curriculum

Weaving Stage (Local Wisdom)	Chemical Concepts	Curricular Relevance
Fiber Selection (Cotton/Silk)	Natural Polymers & Cellulose Structure	Polymers (Grade XII)
Natural Dye Extraction	Organic Solubility & Extraction	Mixtures & Solutions (Grade X)
Use of Lime and Alum	Coordination Bonds & Complex Ions	Chemical Bonding (Grade XI)
Color Fixation/Drying	Oxidation-Reduction (Redox)	Redox Reactions (Grade XII)

Correlation Analysis: Critical Thinking as a Catalyst for Cultural Literacy

The Pearson correlation analysis yielded a coefficient of 0.504 ($p < 0.05$), indicating a moderately strong positive relationship. This statistical evidence confirms that critical thinking is a prerequisite for deep cultural literacy. Students with higher critical thinking scores are not merely "passive observers" of their culture; they are "analytical observers" who question the *why* and *how* of traditional processes. while

students analyze the necessity of soaking yarn in lime water, they transition from a superficial cultural understanding to a scientific inquiry into pH levels and chemical precipitation. This synergy between critical thinking and cultural context addresses the "cognitive plateau" identified in previous studies (Arvidsson, 2025). By recognizing Sukarara weaving as a "traditional laboratory," students can overcome common misconceptions and develop a more hierarchical and scientific worldview that respects their local identity.

CONCLUSION

This study concludes that while the research instruments for Critical Thinking and Cultural Literacy are statistically reliable¹⁴, there is **no significant correlation or influence** between the two variables among the students investigated ($r = -0.249$, $p = 0.092$). The regression model $Y = 51.129 - 0.170X$ further confirms that critical thinking is not a significant predictor for cultural literacy in this context¹⁶. These results suggest that fostering cultural literacy requires more than general critical thinking skills; it necessitates a structured pedagogical integration of local wisdom, such as Sukarara's ethno. Integrating

Sukarara's local wisdom into the chemistry curriculum serves as a dual-purpose pedagogical tool: it makes abstract chemical concepts more concrete and relevant while simultaneously preserving local cultural identity. This research suggests that ethno-chemistry-based learning can effectively mitigate common misconceptions in chemical bonding by providing a familiar, tangible context. Future research should focus on developing specific ethno-chemistry modules and measuring their direct impact on students' learning outcomes across broader geographical contexts.

RECOMMENDATION

Based on the findings of this study, which identified a "literacy paradox" where high instrument reliability did not translate into a significant correlation between variables, the following recommendations are proposed.

Contextualized Pedagogical Shifts

The study reveals that general critical thinking skills do not automatically enhance cultural literacy. Therefore, chemistry educators should

transition from teaching abstract critical thinking to **Ethno-chemistry-oriented Problem-Based Learning (PBL)**. Students must be explicitly guided to apply their analytical logic to deconstruct the chemical processes in Sukarara weaving, such as the mechanism of mordants in color fixation and the molecular stability of natural pigments.

Explicit Curriculum Integration

To bridge the gap between "school chemistry" and "cultural practice," there is an urgent need for structured ethno-chemistry modules. These modules should specifically describe traditional practices into scientific concepts, such as:

Coordination Chemistry: Analyzing how metal ions in alum or lime bind to natural dye molecules like curcumin or indigo.

Acid-Base Equilibria: Explaining the color shifts in natural extracts when exposed to different pH levels during the dyeing process.

Teacher Professional Development

Institutions should provide training to improve teachers' **Pedagogical Content Knowledge (PCK)** in ethno-chemistry. Teachers need to act as "cultural translators" who can transform the traditional tacit knowledge of Sukarara weavers

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into explicit scientific inquiry that stimulates student interest and cultural pride.

Directions for Future Research

Given the non-significant results in this sample (N=47, p=0.092), future studies should consider:

Expanding Sample Size: To increase statistical power and more accurately capture the relationship between cognitive variables.

Longitudinal Designs: To observe the long-term impact of ethno-chemistry interventions on student literacy.

Qualitative Inquiry: Conducting in-depth interviews to explore why students with high critical thinking perceptions might remain skeptical or struggle to link scientific theory with their local heritage.