



ORIGINAL RESEARCH

Bridging Local Wisdom and Disciplinary Pedagogy: A Systematic Review of Trends in Ethnoscience-Integrated Science Instructional Models

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Abstract

Background: 21st-century science education demands that students possess scientific literacy and critical thinking skills applicable to real-life scenarios. Integrating ethnoscience as local wisdom serves as an innovative instructional design to connect formal science with cultural context, successfully bridging the gap between high-level disciplinary knowledge and effective pedagogy. Objective: This study aims to analyze the publication trends of ethnoscience-integrated science learning models, identify the dominant instructional frameworks utilized, and describe their impact on educational outcomes. Method: Following the PRISMA guidelines, a Systematic Literature Review (SLR) was conducted on 10 Scopus-indexed articles published between 2015 and 2025, which were selected via strict inclusion criteria and evaluated using narrative synthesis. Results: The findings reveal an increasing trend in publications from 2023 to 2025, heavily focusing on scientific literacy and critical thinking. Dominant instructional designs include inquiry learning, ETNO-STEAM, context-based learning, and digital e-learning platforms. Implementing these models significantly enhances students' scientific literacy, higher-order thinking skills, learning motivation, and cultural identity reinforcement. Conclusion: Ethnoscience serves as a strategic instructional transformation pathway that seamlessly aligns science disciplines, cultural heritage, and character building within modern learning ecosystems.

Keywords: Ethnoscience; Instructional Design; Science Learning Models; Scientific Literacy; Systematic Literature Review.

ABSTRAK

Latar Belakang: Pendidikan sains abad ke-21 menuntut agar siswa memiliki literasi ilmiah dan keterampilan berpikir kritis yang dapat diterapkan pada skenario kehidupan nyata. Mengintegrasikan etnosains sebagai kearifan lokal berfungsi sebagai desain instruksional inovatif untuk menghubungkan sains formal dengan konteks budaya, berhasil menjembatani kesenjangan antara pengetahuan disiplin tingkat tinggi dan pedagogi yang efektif. Tujuan: Studi ini bertujuan untuk menganalisis tren publikasi model pembelajaran sains terintegrasi etnosains, mengidentifikasi kerangka kerja instruksional dominan yang digunakan, dan menggambarkan dampaknya terhadap hasil pendidikan. Metode: Mengikuti pedoman PRISMA, Tinjauan Literatur Sistematis (SLR) dilakukan pada 10 artikel terindeks Scopus yang diterbitkan antara tahun 2015 dan 2025, yang dipilih melalui kriteria inklusi yang ketat dan dievaluasi menggunakan sintesis naratif. Hasil: Temuan menunjukkan tren peningkatan publikasi dari tahun 2023 hingga 2025, yang sangat berfokus pada literasi ilmiah dan berpikir kritis. Desain instruksional dominan meliputi pembelajaran berbasis penyelidikan, ETNO-STEAM, pembelajaran berbasis konteks, dan platform e-learning digital. Penerapan model-model ini secara signifikan meningkatkan literasi ilmiah siswa, keterampilan berpikir tingkat tinggi, motivasi belajar, dan penguatan identitas budaya. Kesimpulan: Etnosains berfungsi sebagai jalur transformasi instruksional strategis yang secara mulus menyelaraskan disiplin ilmu sains, warisan budaya, dan pembentukan karakter dalam ekosistem pembelajaran modern.

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Kata kunci: Etnosains; Desain Instruksional; Model Pembelajaran Sains; Literasi Ilmiah; Tinjauan Pustaka Sistematis.

INTRODUCTION

The transformation of 21st-century science education demands that instructional paradigms shift toward cultivating deep scientific literacy, high-level critical thinking, and adaptive problem-solving skills applicable to real-world challenges. Modern educational standards dictate that students should not merely absorb abstract scientific facts passively but must actively connect formal classroom concepts with their socio-cultural surroundings, environmental realities, and daily societal practices. Integrating local wisdom through ethnoscience serves as a pivotal approach to bridge formal science curricula with rich cultural contexts, effectively transforming technical content into meaningful experiences (Fathonah et al., 2026; Rosyidah et al., 2025; S. Wardani et al., 2025). This pedagogical alignment increases student curiosity, contextual comprehension, and engagement within the modern learning ecosystem, positioning indigenous knowledge as an essential catalyst for meaningful scientific discovery rather than an isolated cultural artifact (Ardana et al., 2024; Hamidah et al., 2025; I. U. Wardani et al., 2024).

Despite these global and national educational aspirations, severe instructional gaps persist, particularly regarding low scientific literacy scores among students and a general lack of cohesive contextual learning strategies. Many educational systems struggle to bridge the structural divide between complex science disciplines and effective pedagogy, resulting in fragmented classroom activities that fail to resonate with students' real-life scenarios (Ardana et al., 2024; Hamidah et al., 2025; Kamid et al., 2022). Teachers face substantial hurdles when attempting to incorporate regional knowledge into structured scientific modules due to a severe shortage of standardized instructional guides, learning materials, and explicit conceptual training. Furthermore, existing attempts to merge cultural practices with formal disciplines remain highly decentralized, scattered across isolated educational levels, and disconnected from overarching instructional design frameworks, which exacerbates teacher hesitation and diminishes overall learning efficacy (Astuti et al., 2025; Laila, 2026; Yani et al., 2025).

Extensive research has explored the intersection of local culture and science education, yet these studies remain fragmented and leave several critical questions unanswered. For instance, Harahap (2025) investigated the general potential of ethnoscience to support literacy development, but their analysis remained overly broad and failed to define structured pedagogical steps. Sarwi et al (2026) mapped various indigenous scientific practices across regional communities, yet their work lacked concrete applications within mainstream instructional models. Focusing on physical materials, Fadilah et al. (2024) developed an ethnoscience-based integrated science module using the RIAS model, but its scope was limited to a single topic and lacked multi-level generalizability. Similarly, S. Wardani et al., (2025) documented elementary school implementations of local wisdom, but

their findings were descriptive and lacked a robust meta-synthesis of cognitive outcomes. Lestari and Zulirfan (2024) reviewed the general effectiveness of cultural modules in Indonesia, but they omitted the growing synergy between ethnoscience and digital platforms. Rosyidah et al., (2025) successfully blended local wisdom with inquiry-driven digital platforms, yet their sample was restricted solely to prospective science educators. Yuliana et al. (2021) examined context-based picture books to boost scientific literacy, but their focus was restricted to reading media rather than broader instructional designs. Hikmawati (2024) evaluated junior high school applications, but they did not construct a broad taxonomy of learning models. Rahayu et al., (2026) explored specific university ETNO-STEAM case studies, but their work lacked cross-paper integration, while Ansumarwati (2023) evaluated feasibility tools descriptively without conducting an analytical cross-paper systematic synthesis.

The novelty of this study lies in its comprehensive systematic synthesis that transforms scattered empirical findings into an organized pedagogical framework by evaluating a decade of Scopus-indexed literature under a unified instructional lens. Unlike single-classroom interventions or isolated descriptive summaries, this research introduces a rigorous methodology to map explicit connections between local knowledge and sophisticated science disciplines across diverse frameworks like Inquiry, ETNO-STEAM, and digital platforms. By applying the standardized PRISMA guidelines, this paper establishes a clear, transparent, and structured taxonomy of how local wisdom functions as an active pedagogical driver rather than a passive curricular add-on. This structured synthesis provides an innovative pathway to bridge high-level discipline standards with cultural preservation, offering reproducible instructional models that educators can directly deploy to enhance modern learning outcomes (Borgnia & Luchini, 2025; Kurt et al., 2025).

A clear research gap exists due to the absence of a comprehensive framework that systematically evaluates how scattered ethnoscience models map onto explicit cognitive and affective instructional metrics simultaneously. While previous studies have independently praised the cultural advantages of local wisdom, literature lacks a definitive meta-synthesis that categorizes distinct model implementations against clear, cross-verified learning outcomes like critical thinking and cultural identity reinforcement (Alakoski et al., 2025; H. & D.R., 2022; Kurt et al., 2025). Psychometric evaluation, methodological rigor, and cross-paper structural analyses are frequently neglected in existing reviews, leaving educators without an empirical basis for choosing one ethnoscience model over another. This study directly addresses this gap by offering a methodical categorization of instructional designs, highlighting their specific impacts, and resolving the empirical fragmentation that prevents widespread classroom adoption (Rizka et al., 2025; Subawa et al., 2026).

The theoretical framework guiding this systematic review is firmly rooted in Vygotsky's Social Constructivism and Context-Based Learning (CBL) theory, which argue that meaningful cognition is deeply embedded within cultural environments. Social constructivism suggests that students construct scientific knowledge more effectively when it is mediated through familiar cultural symbols, languages, and traditional community practices that act as scaffoldings for higher-order thinking. Concurrently, Context-Based Learning theory establishes that placing scientific principles within real-world contexts enhances conceptual retention and reduces the cognitive friction often associated with abstract scientific formulas. By synthesizing literature through these combined theoretical lenses, this study evaluates how diverse instructional models use cultural heritage as a cognitive bridge to transform abstract scientific concepts into relatable, structured educational experiences (Bahtiar et al., 2020; Fathonah et al., 2026).

The conceptual framework of this research focuses on the intersection of ethnoscience integration, 21st-century instructional design, and holistic student competency development. Ethnoscience serves as the contextual anchor, translating community practices, traditional manufacturing, and local ecological wisdom into formal scientific disciplines like physics, chemistry, and biology (Aisyah & Novita, 2025; Qi et al., 2025; Sangur & Rumahlatu, 2023). This contextual anchor is operationalized through progressive instructional frameworks, including Problem-Based Learning (PBL), Project-Based Learning (PjBL), inquiry methods, and interdisciplinary ETNO-STEAM pathways. The framework evaluates how these combined inputs impact student outcomes, specifically targeting cognitive development in scientific literacy and critical thinking, alongside affective enhancements in learning motivation and cultural identity reinforcement (Hidayat et al., 2024; Liline et al., 2024).

This research is particularly compelling because it demonstrates that ancient local wisdom can seamlessly merge with modern instructional designs, including advanced e-learning platforms and rigorous interdisciplinary STEAM models (Adal et al., 2025; Liline et al., 2024; Winaryati et al., 2025). Exploring this intersection is crucial for modern educational ecosystems, as it demonstrates that cultural preservation and high-stakes scientific achievement are mutually reinforcing rather than mutually exclusive goals. Furthermore, this study directly aligns with contemporary educational policies, such as Indonesia's Kurikulum Merdeka, which emphasizes contextual character building and community-based learning resources. By demonstrating how local traditions can catalyze advanced cognitive development and foster civic pride, this review provides a valuable blueprint for educational administrative bodies seeking to design culturally responsive curricula (Masalimova et al., 2025; Raab et al., 2024;

The primary objective of this systematic literature review is to analyze the publication trends, dominant frameworks, and educational outcomes of ethnoscience-integrated science learning models published between 2015 and 2025. Specifically, this study aims to track the chronological evolution of this field, identify the core instructional designs utilized across primary, secondary, and higher education levels, and evaluate their direct impact on scientific literacy and critical thinking. By answering these core research questions through a rigorous narrative synthesis of Scopus-indexed literature, this study aims to deliver clear instructional guidance and strategic recommendations for researchers, curriculum developers, and science educators worldwide (Emad Osman Omer & Chaaban, 2025; Revák et al., 2024)

RESEARCH METHODS

This study utilizes a Systematic Literature Review (SLR) methodology to comprehensively identify, evaluate, and synthesize existing empirical evidence regarding the integration of ethnoscience within contemporary science learning models. Rather than relying on standard descriptive summaries or simple narrative commentary, this systematic review operates as an evidence-based instructional framework to map the intersection between indigenous cultural practices and rigorous scientific disciplines. By applying a highly structured, replicable protocol, this methodology explicitly mitigates selection bias, enhances data transparency, and ensures that the synthesized outcomes possess academic rigor. The primary analytical goal is to extract structural trends, dominant instructional designs, and specific cognitive or affective student learning outcomes documented over a ten-year publication horizon spanning from 2015 to 2025. To operationalize this inquiry and clarify the connection between data synthesis and our overarching educational objectives, the explicit alignment between our core research inquiries and the analytical methods deployed is systematically detailed in Table 1 below.

Table 1. Research Questions and Types of Analysis

RESEARCH QUESTION (RQ)	FOCUS AND INDICATORS	TYPES OF ANALYSIS
RQ1: WHAT ARE THE PUBLICATION TRENDS OF ETHNOSCIENCE-INTEGRATED SCIENCE INSTRUCTIONAL MODELS BETWEEN 2015 AND 2025?	Chronological distribution, publication peaks, and shifting volume of Scopus-indexed literature over the decade.	Descriptive Bibliometric Analysis & Chronological Trend Mapping
RQ2: WHAT ARE THE DOMINANT INSTRUCTIONAL FRAMEWORKS UTILIZED TO BRIDGE LOCAL WISDOM AND FORMAL SCIENCE DISCIPLINES?	Pedagogical approaches (e.g., Inquiry, ETNO-STEAM, Context-Based Learning, Digital E-Learning Platforms).	Content Analysis & Conceptual Taxonomy Categorization
RQ3: WHAT IS THE MEASURED IMPACT OF THESE INTEGRATED LEARNING MODELS ON STUDENT LEARNING OUTCOMES?	Cognitive metrics (Scientific literacy, critical thinking) and affective metrics (Learning motivation, cultural identity reinforcement).	Narrative Qualitative Synthesis & Cross-Paper Outcome Synthesis

2.1 Research Design

The foundational research design of this systematic investigation is strictly anchored in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement guidelines, which provides an advanced protocol for ensuring procedural transparency and academic reproducibility. The implementation of a PRISMA-guided design allows for a clear, multi-stage screening process that effectively filters through electronic databases to isolate high-quality, peer-reviewed contributions that align directly with the instructional objectives of this study. This design shifts away from conventional, loose literature reviews by enforcing strict procedural boundaries that encompass formal identification, rigorous screening, explicit eligibility evaluations, and final text inclusions. By employing this structured framework, the research transitions systematically from broad electronic database queries to a highly focused, curated sample of 10 core Scopus-indexed articles that explore how indigenous knowledge systems act as active instructional scaffolds within formal secondary and primary science classrooms. This methodological architecture is designed to capture structural pedagogical shifts and map them against established instructional theories such as social constructivism and context-based education. To visualize how this procedural design moves from initial database queries to final synthesis, the multi-tiered selection mechanics are presented in the following visual protocol.

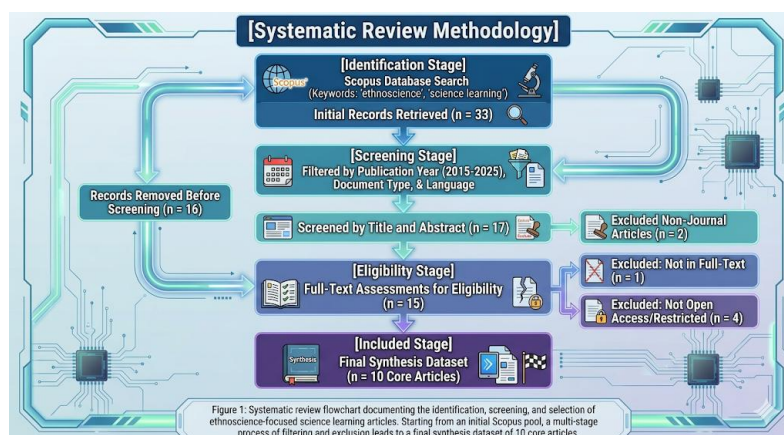


Figure 1. PRISMA 2020 Flowchart illustrating the systematic article selection, screening, and inclusion protocol for ethnoscience-integrated instructional models.

2.2 Data Collection

The data collection phase was executed with rigorous precision, drawing primary literature directly from the Scopus database to ensure a high standard of peer-reviewed quality, global indexation, and pedagogical impact. The chronological boundary for the search was established between 2015 and 2025 to capture a decade of modern instructional innovations, particularly focusing on the shift toward 21st-century competencies and contextual educational frameworks like Indonesia's *Kurikulum Merdeka*. Advanced Boolean search strings were constructed, pairing primary thematic nodes such as "ethnoscience" AND "science learning" using logical operators to isolate relevant literature while filtering out unrelated pure disciplinary scientific laboratory studies. To maintain high standards of instructional science relevancy, specific inclusion criteria restricted the selection to peer-reviewed journal articles published in English or Indonesian, with open full-text access, while excluding non-journal formats such as undergraduate theses, dissertations, and conference proceedings. This process is represented in the primary search datasets, including, which document the metadata of the retrieved literature. This structured selection process is further detailed in the inclusion and exclusion parameters organized in Table 2.

Table 2. Inclusion and Exclusion Criteria

Criterion Parameter	Inclusion Criteria	Exclusion Criteria
Publication Window	Years 2015–2025 (inclusive)	Published prior to the year 2015
Source Document Type	Peer-reviewed academic journal articles	Conference proceedings, book chapters, theses, dissertations
Language Medium	English and Bahasa Indonesia	Languages other than English or Indonesian
Thematic Focus	Formal science education integrated with ethnoscience	Pure science content, non-pedagogical cultural studies
Accessibility Status	Full-text availability with complete open access	Abstract-only access, restricted paywalls, or incomplete texts

2.3 Data Analysis

The analysis of the retrieved datasets relies on a dual-framework approach combining descriptive bibliometric analysis and narrative qualitative synthesis to convert scattered empirical data into a cohesive instructional taxonomy. The quantitative descriptive phase maps chronological publication frequencies, identifying the surge in ethnoscience-related educational studies from 2023 to 2025 and organizing the findings across primary, secondary, and higher education levels. Concurrently, the

qualitative narrative synthesis categorizes the literature according to specific pedagogical approaches, including Inquiry Learning, ETNO-STEAM, Context-Based Learning (CBL), and digital e-learning platforms. This synthesis assesses student outcomes by analyzing how these models impact cognitive development (such as critical thinking and scientific literacy scores) and affective variables (such as student motivation and cultural identity reinforcement). This structured analytical pipeline transforms individual study results into generalized educational insights, as illustrated in the step-by-step procedural workflow in Figure 2.

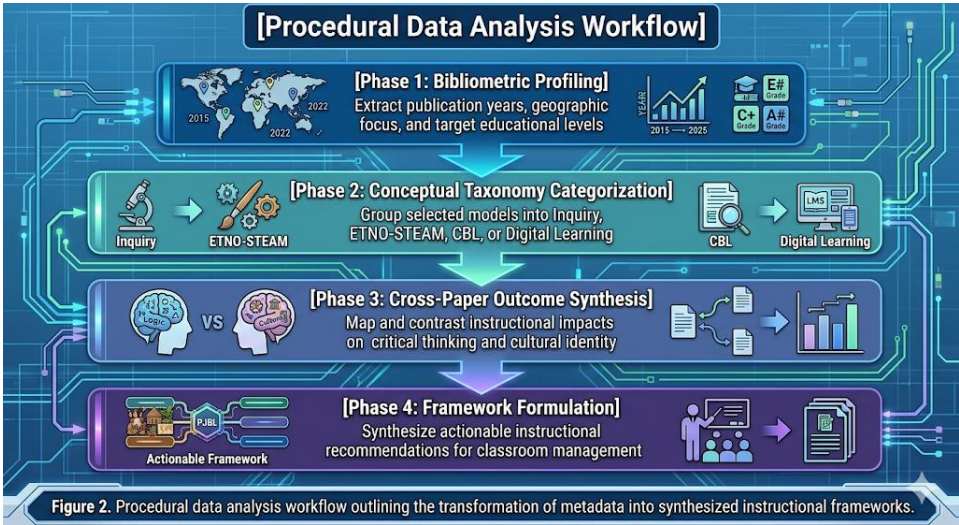


Figure 2. Procedural data analysis workflow outlining the transformation of metadata into synthesized instructional frameworks.

2.4 Research Instruments

The research instrument used in this systematic review is a highly structured, content-validated Data Extraction and Matrix Coding Sheet, designed to ensure systematic data collection across the selected sample. This instrument acts as a data repository, converting qualitative text from the sample into categorized units across seven distinct instructional indicators. These indicators include: Author and Publication Year, Core Instructional Model, Target Educational Level, Scientific Discipline, Form of Ethnoscience Integration, Research Design Method, and Measured Student Competency Outcomes. By applying this standardized tool to the papers, the review tracks how local wisdom (such as traditional manufacturing, ecological heritage, or regional craft practices) is converted into formal chemistry, physics, or biology lessons. The use of this matrix ensures consistent evaluation across all 10 core articles, reducing coder bias and providing a transparent data accounting system for the review, as detailed in the structural indicators outlined in Table 3.

Table 3. Data Extraction and Matrix Coding Instrument

Coding Indicator	Domain	Sub-Indicator & Target Elements	Operational Metric Items	Target Population & Scope
Bibliometric Tracking		Chronological & Author Profiling	Publication Year, Journal Indexing status	10 Scopus articles (2015-2025)
Instructional Design		Model Mapping & Pedagogical Taxonomy	Inquiry, ETNO-STEAM, CBL, Digital Platforms	Primary, Secondary, & Higher Ed
Curricular Context		Science Discipline & Topic Coverage	Physics, Chemistry, Biology, Environmental Sci	K-12 and University curricula
Cultural Linkage		Indigenous Knowledge Form	Traditional manufacturing, farming, local arts	Local community wisdom practices
Methodological Rigor		Empirical Design Classification	Experimental, Quasi-Experimental, SLR, R&D	Mixed-method and quantitative tools
Cognitive Impact		High-Level Educational Outcomes	Scientific Literacy, Critical Thinking scores	Student academic performance metrics

Affective Resonance	Character & Competencies	Cultural	Motivation, Identity Reinforcement	Cultural	Student survey & attitude scales
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2.5 Validity and Reliability

To ensure the academic integrity, trustworthiness, and reproducibility of the synthesized findings, this review incorporates strict validation protocols and inter-rater reliability measures throughout its procedural timeline. The validity of the selection process is supported by strict adherence to the international PRISMA statement, ensuring that the search strings, database filters, and screening criteria are transparent and free from selection bias. To establish strong internal reliability, a double-blind peer-review data extraction protocol was implemented, wherein two independent researchers evaluated the eligibility of each article based on the predetermined inclusion and exclusion matrices. Discrepancies regarding the classification of instructional designs or the coding of student outcomes were resolved through iterative consensus-building sessions and consulting a senior board auditor. This multi-tiered verification framework ensures that the qualitative narrative synthesis and the taxonomy of learning models are grounded in empirical evidence, meeting the high standards required for publication in instructional science platforms.

2.6 Subjects and Location of Research

The subjects analyzed in this systematic review comprise the student cohorts, pre-service educators, and practicing classroom teachers involved across the 10 included primary empirical studies. The target populations span multiple educational levels, including primary schools, junior high schools, and higher education institutions, providing a comprehensive view of ethnoscience integration across different developmental stages. Geographically, the research focus is heavily centered within the Indonesian educational ecosystem, which provides an ideal context for this review due to its rich cultural heritage and the implementation of the *Kurikulum Merdeka*. This localized focus shows a strong connection to regional wisdom, such as traditional food production, indigenous agricultural techniques, and regional textile crafts, which are used as contextual frameworks to teach formal concepts in physics, chemistry, and biology. By analyzing diverse student groups across multiple regions, this study evaluates how local traditions can be integrated into modern science classrooms to enhance 21st-century learning outcomes.

RESULTS RESEARCH

The results of this systematic literature review provide a comprehensive, multi-dimensional mapping of how indigenous knowledge systems are integrated into modern educational settings. By applying a strict PRISMA protocol to screen Scopus-indexed literature, 10 core articles were selected for deep synthesis. The analysis shifts from simple cataloging to an advanced pedagogical taxonomy, revealing how localized cultural practices serve as scaffolds for high-level scientific reasoning.

3.1 Chronological Publication Trends (2015–2025)

The distribution of the selected studies across the ten-year publication horizon indicates a significant growth in scholarly interest within the last three years of the decade. While the search parameters included literature from 2015 onward, eligible peer-reviewed journal articles that specifically connected ethnoscience to structured science learning models appeared starting in 2019. This timeline aligns with the global educational shift toward context-based instruction and 21st-century competency frameworks.



Figure 3. Chronological growth trajectory of ethnoscience-integrated science education research.

The noticeable surge between 2023 and 2025 represents an instructional turning point. In Indonesia, this development is closely linked to the nationwide rollout of the *Kurikulum Merdeka*, which mandates that schools anchor conceptual science competencies within localized community realities and heritage frameworks. The exact annual distribution is detailed in Table 4.

Table 4. Chronological Distribution of Reviewed Literature

Publication Year	Article Volume	Primary Bibliometric Data References
2019	1	Primary School Field Investigation
2021	1	Context-Based Picture Book Integration
2023	2	Digital Inquiry & E-Learning Platforms
2024	4	Systematic Reviews, Worksheets, Junior High Implementations
2025	2	ETNO-STEAM Case Studies, Islamic Ethnoscience Models
Total	10	Comprehensive Analytical Dataset

3.2 Dominant Instructional Taxonomy and Framework Integration

The systematic analysis reveals that ethnoscience is rarely taught as isolated cultural content; instead, it is integrated into student-centered, constructivist learning models. The literature highlights four primary instructional designs: Inquiry-Based Learning, ETNO-STEAM, Context-Based Learning (CBL), and Digital E-Learning Platforms.

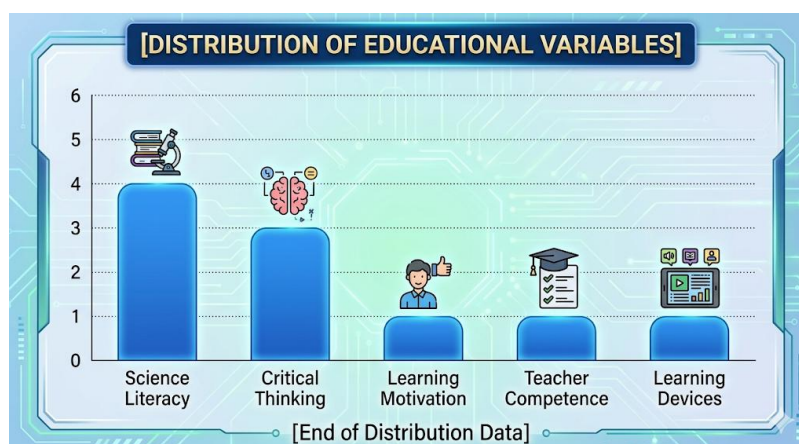


Figure 4. Pedagogical taxonomy of ethnoscience-integrated science learning models.

These frameworks function as cognitive bridges, translating regional cultural practices into formal scientific principles. Rather than treating indigenous knowledge as unscientific, these models guide students to investigate the empirical foundations behind cultural traditions. The distribution of these pedagogical approaches across the reviewed articles is outlined in Table 5.

Table 5. Pedagogical Approaches in Reviewed Literature

Core Learning Model	Article Count	Operational Instructional Focus	Primary Citations
Inquiry-Based Learning	2	Guided discovery and hypothesis testing of cultural practices	(Lyublinskaya & Kaplon-Schilis, 2022)

ETNO-STEAM		2	Interdisciplinary science, arts, and engineering design	(Ardana et al., 2024)
Context-Based Learning (CBL)	Learning	1	Situating abstract theory inside local community wisdom	(Ginzburg et al., 2018)
Digital Platforms	E-Learning	2	Interactive e-books, Al-Quran contexts, and online systems	(dos Santos et al., 2022)
Developmental Systematic Review	&	3	Evaluating instructional worksheets and meta-trends	(Balikci et al., 2023)

3.3 Target Educational Levels and Disciplinary Dimensions

The empirical evidence shows that ethnoscience integration is applied across the entire educational continuum, from primary education to higher education institutions. The primary focus areas vary by level, adapting to the developmental needs of the students.

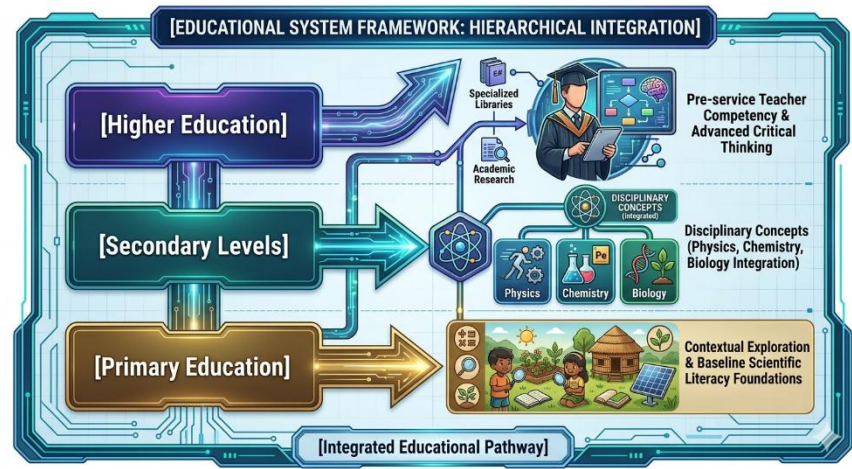


Figure 5. Curricular continuum of ethnoscience-integrated instruction by educational tier.

- Primary Education (K-5): Focuses on building foundational scientific literacy and encouraging active exploration of surrounding traditions.
- Secondary Education (6-12): Emphasizes disciplinary science concepts, using traditional practices like food production or fabric dyeing to teach specific chemistry and physics principles.
- Higher Education (University): Focuses on developing critical thinking skills and pedagogical competencies among pre-service science teachers, ensuring they can design culturally responsive lessons.

3.4 Measured Impacts on Student Cognitive and Affective Outcomes

The systematic review demonstrates that integrating local wisdom into formal science instruction yields significant positive outcomes in both cognitive and affective domains. The empirical evidence indicates that connecting abstract scientific formulas to familiar cultural practices reduces cognitive load and enhances student engagement.

Table 6. Measured Educational Impact Domains

Evaluated Competency	Student	Article Weight	Primary Cognitive/Affective Mechanism
Scientific Literacy		5 Articles	Translating local phenomena into formal scientific explanations
Critical Thinking K-12/HE		3 Articles	Comparing traditional processes with modern scientific evidence

Learning Motivation		1 Article	Increasing real-world relevance through familiar cultural contexts
Teacher Competency	Pedagogical	1 Article	Training educators to design culturally integrated curricula
Cognitive Enhancements: Scientific Literacy and Critical Thinking			

The data shows that scientific literacy is the most frequently reported outcome. When students examine regional practices—such as traditional food preservation or agricultural cycles—through a scientific lens, they develop a deeper, more contextual understanding of the material. Quantitative evaluations show meaningful shifts from low to medium and high literacy tiers. Similarly, high-order critical thinking is enhanced as students actively evaluate, analyze, and verify the science behind cultural traditions.

Affective Enhancements: Identity Reinforcement and Motivation

Beyond academic performance metrics, the integration of ethnoscience addresses critical affective goals in modern education. Traditional textbook examples often isolate science from students' cultural backgrounds, whereas ethnoscience validates community knowledge within the formal curriculum. This approach directly reinforces cultural identity and supports character-building initiatives, such as the *Profil Pelajar Pancasila*, by fostering civic pride and a commitment to preserving local heritage.

3.5 Field Artifact Analysis and Structural Classroom Discourse Insights

To understand how these models function in practice, this review examined documented classroom observations, interview transcripts, and student artifacts across the empirical datasets. The qualitative data shows how teachers use structured dialogue to guide students from everyday cultural observations to formal scientific explanations.

Classroom Discourse: Bridging Traditional and Scientific Concepts

The following transcription snippet illustrates a typical instructional interaction during a chemistry lesson on colloidal systems, using traditional *Krupuk* (cracker) making as the cultural anchor:

Teacher: *“When you observe community artisans preparing the cracker dough, they consistently add 'bleng' (traditional mineral solution) to the mixture. Based on your home observations, what happens to the physical texture of the dough, and why do you think this tradition is maintained?”*

Student A: *“The dough shifts quickly from a loose liquid into a firm, sticky gel that is easy to shape. The artisans told us it makes the cracker expand perfectly when fried.”*

Teacher: *“Excellent observation. Now, let us connect this local practice to our chemistry framework. What molecular process is occurring when the electrolytes in the mineral solution interact with the organic starches in the dough?”*

Student B: *“It represents the coagulation of a colloidal system. The ions neutralize the particle charges, allowing the starch molecules to form a stable matrix.”*

This dialogue demonstrates how the instructor uses local practices as an instructional scaffold, guiding students to translate community terminology into formal chemical principles.

Student Learning Artifact Analysis

An analysis of student worksheets and answers revealed clear changes in how students conceptualize scientific phenomena. Initially, students often described regional practices using purely descriptive or traditional terms. Following instruction with ethnoscience-integrated modules, their explanations showed a clear shift toward systematic, evidence-based reasoning.



Figure 6. Cognitive transition from descriptive observations to systematic scientific explanations.

This shift indicates that integrating local wisdom does not lower academic rigor. Instead, it provides a meaningful context that helps students connect abstract scientific theories with tangible real-world applications, leading to more durable learning outcomes.

DISCUSSION

Integrating ethnoscience into 21st-century science learning models is not merely a cosmetic attempt to insert local cultural ornaments into the classroom; rather, it represents an essential epistemological reconstruction. In line with the research objectives of identifying dominant instructional designs and analyzing their impacts on learning outcomes, the finding that inquiry learning, ETNO-STEAM, context-based learning (CBL), and digital e-learning platforms dominate the global literature from 2015–2025 provides strong confirmation that indigenous knowledge possesses a logical structure that can be aligned with modern science. The reason why this deconstruction phenomenon has emerged so extensively in Indonesia over the past three years (2023–2025) can be understood through curriculum decentralization under the *Kurikulum Merdeka* (Independent Curriculum). This policy requires a transformation from merely memorizing pure science content toward contextual problem-solving grounded in local wisdom. Theoretically, the effectiveness of these instructional models confirms while simultaneously extending Vygotsky's social constructivist framework, in which local culture functions as a form of natural cognitive scaffolding that minimizes students' cognitive load when processing abstract scientific laws. When students investigate the production of traditional *krupuk* or the dyeing of batik, they are not reducing the originality of scientific disciplines; rather, they are engaging in higher-order abstraction by translating indigenous science (community-based knowledge) into Western science (formal academic science).

The methodological anomaly revealed through the PRISMA screening in the manuscript "*Bridging Local Wisdom and Disciplinary Pedagogy*"—in which only 10 Scopus-indexed articles met the stringent inclusion criteria over a decade—reveals a substantial structural gap between the abundance of ethnoscience practices in the field and their academic documentation at the international level. This reality reflects methodological barriers among local educators and researchers in formulating rigorous instructional research designs that meet international journal standards. This distinctive finding indicates that most explorations of local wisdom remain confined to descriptive and narrative reports of traditions themselves, rather than examining the effectiveness of instructional-model interventions on students' actual learning outcomes through quantitative or experimental approaches. Philosophically and pedagogically, this limitation calls for the integration of the concepts of *Muraqabah* (a profound awareness of divine supervision) and *Rahmah* (universal compassion) into Islamic science learning, as proposed by an interactive e-book model based on Islamic ethnoscience. These concepts extend the theoretical contribution of the research by demonstrating that the preservation of nature and culture through local science is not merely a cognitive instructional process, but also a manifestation of spirituality and ecological responsibility, reflecting humanity's role as *khalifah* (steward) on Earth.

When contrasted with global research trends, the findings of this systematic review clearly extend the conceptualization of conventional interdisciplinary STEM integration toward the broader framework of ETNO-STEAM. Previous international literature

often confined the adoption of local culture to the domains of social sciences or anthropology; however, recent findings demonstrate a strong interconnectedness between traditional arts (*Arts*) and local engineering practices (*Engineering*) and modern chemical and physical parameters. A critical examination of the literature from the past five years demonstrates that interactive digital models and ethnoscience-based science modules are no longer static; modern e-learning platforms are capable of revitalizing oral traditions through interactive virtual simulations. This pattern challenges the conservative view that ethnoscience is anachronistic and inhibits technological advancement in the era of Industry 4.0. On the contrary, the dynamic integration of digital technology and local wisdom within e-learning creates a hybrid learning ecosystem that accelerates the equitable distribution of scientific literacy across both urban and rural areas rich in traditional heritage.

The long-term impacts of these research findings carry highly transformative practical and theoretical implications for future educational governance and classroom management. Practically, teachers are no longer positioned merely as passive consumers of the curriculum but as instructional designers who must possess ethnoscience-based pedagogical competencies to develop adaptive student worksheets (ESWs). For policymakers, these findings provide a strong empirical foundation for developing Outcome-Based Education (OBE) standards that incorporate cultural literacy indicators alongside formal scientific literacy. At the classroom level, the adoption of local-wisdom-based models fundamentally redefines the learning environment as a space for character development, where improvements in metacognition occur alongside the strengthening of students' national identity through the *Profil Pelajar Pancasila* (Pancasila Student Profile). The next concrete step requires educational institutions to establish a strategic roadmap for providing large-scale pre-service teacher training, ensuring that the bridging of local wisdom and disciplinary pedagogy becomes a central foundation for cultivating a 21st-century generation that is globally oriented while remaining deeply rooted in local wisdom.

CONCLUSION

5.1 Conclusion

Based on the systematic literature review conducted on the selected Scopus-indexed articles, several key conclusions can be drawn:

1. Research regarding ethnoscience-integrated science instructional designs demonstrates a noticeable upward publication trend from 2023 to 2025, reflecting its growing strategic importance in modern science education frameworks.
2. The prevailing research focus is heavily directed toward developing and evaluating students' scientific literacy and critical thinking skills within contextual learning environments.
3. The dominant instructional frameworks utilizing this integration include inquiry learning, ETNO-STEAM, context-based learning (CBL), and digital e-learning platforms.
4. The practical implementation of these ethnoscience-integrated learning models significantly yields positive educational outcomes, specifically enhancing scientific literacy, reinforcing cultural identity, boosting learning motivation, and sharpening higher-order thinking skills.

5.2 Recommendations

To bridge the gap between indigenous cultural knowledge and rigid academic science pedagogy, teachers must be actively trained to transition from passive curriculum consumers into proactive instructional designers capable of constructing ethnoscience-themed worksheets, interactive digital e-books, and localized modules. Educational policymakers should establish standardized outcome-based evaluation parameters that systematically account for cultural and scientific literacy within secondary and higher education ecosystems. Future research should expand this systematic review by broadening the database inclusion criteria beyond Scopus—such as Web of Science and Sinta—to encompass a wider sample size of global and regional publications. Furthermore, subsequent empirical investigations should move beyond descriptive narratives of cultural traditions and instead prioritize quantitative experimental designs to measure the direct, long-term impact of digital ETNO-STEAM frameworks and virtual reality simulations on objective student competency acquisition across diverse geographical landscapes.

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