

ETHNOSCIENCE-BASED E-FLIPBOOK FOR ENHANCING SCIENCE LITERACY IN ELEMENTARY SCHOOL: A LITERATURE REVIEW

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ARTICLE HISTORY

Received : 20-01-2026

Revised : 07-02-2026

Accepted : 25-05-2026

KEYWORDS

*E-Flipbook,
Ethnoscience, Science
Literacy, Elementary
School, Kue Lapis*

ABSTRACT

Science literacy remains a critical yet persistently underdeveloped competency among elementary school students in Indonesia, as evidenced by consistently below-average PISA scores and classroom-level literacy gaps. This literature review aims to establish the theoretical and empirical foundations for developing an ethnoscience-based electronic flipbook (e-flipbook) as a culturally responsive instructional medium to enhance science literacy among Grade 4 elementary school students. Following PRISMA guidelines, a systematic search was conducted across Google Scholar, ERIC, Scopus, and SINTA databases, yielding 42 peer-reviewed articles (2022–2025) organized into four thematic domains: science literacy in elementary education, ethnoscience in science learning, e-flipbook as digital media, and local wisdom integration in science curricula. Findings reveal that ethnoscience-based learning effectively bridges indigenous cultural knowledge with formal science concepts, that e-flipbooks consistently enhance student engagement, motivation, and conceptual understanding, and that the Kampung Kue Rungkut context in Surabaya particularly kue lapis production provides an authentic, curriculum-aligned ethnoscience source for matter state change learning. This review concludes that developing an e-flipbook grounded in the Kampung Kue Rungkut context holds strong potential as a valid, practical, and effective instructional medium for Grade 4 science literacy. Implications for Merdeka Curriculum implementation and future empirical development research are discussed.

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INTRODUCTION

Science literacy is a foundational 21st-century competency, defined as the ability to understand, apply, and critically reflect upon scientific information in relation to natural phenomena (Yang et al., 2024). In Indonesia, science literacy is a central pillar of the Merdeka Curriculum, emphasizing critical thinking and scientific reasoning from the elementary level. PISA consistently reports Indonesian students below the international science average, while Permendikdasmen Number 10 of 2025 mandates evidence-based reasoning as a graduate competency. This persistent gap between policy expectations and student performance signals an urgent need for pedagogically innovative, contextually relevant instructional approaches.

The teaching of Natural Science and Social Studies (IPAS) in elementary schools under the Merdeka Curriculum for Phase B is designed to develop students' conceptual understanding of natural phenomena encountered in their everyday lives. According to the Phase B learning outcomes, Grade 4 students are expected to explain processes of matter state changes and identify sources and forms of energy as well as energy transformation processes in daily life. Achieving these learning outcomes requires more than rote memorization of scientific concepts; it demands that students engage in meaningful learning experiences that connect abstract scientific ideas to observable and familiar contexts. The contextual approach to science learning has been identified as a significant factor in promoting deeper conceptual understanding and sustained scientific curiosity among elementary school students (Suryanti et al., 2021). However, classroom observations at SD Muhammadiyah 4 Pucang Surabaya revealed that students' science literacy levels remain low, as evidenced by their limited ability to interpret natural phenomena scientifically and to connect science concepts to real-life events. This gap between expected competencies and actual student performance underscores the need for innovative instructional media.

Digital technology has transformed educational practices, and interactive digital media now offer new possibilities for engaging science instruction. Technology-integrated tools create structured opportunities for students to explore content meaningfully and independently (Diafi, 2022). Among these, the e-flipbook has emerged as a particularly promising medium, capable of integrating text, images, video, audio, and animation to create a multisensory, interactive learning experience accessible across digital devices. Studies confirm that e-flipbooks substantially improve student engagement, motivation, and learning outcomes when integrated thoughtfully into science instruction (Bunari et al., 2024).

Despite the availability of technological tools, the integration of local cultural wisdom into primary science education remains inadequately developed in many Indonesian schools. Local wisdom encompasses all forms of community knowledge rooted in values that are practiced and preserved across generations within particular cultural environments (Salain & Mahastuti, 2021). Ethnoscience, as a discipline that bridges indigenous knowledge systems with modern scientific understanding, represents a powerful approach for making science education more relevant and culturally responsive. According to Abdjul et al., (2025), local wisdom is an important component for making science learning more relevant, attractive, and effective for students, as it helps preserve cultural identity, develop character, and enhance comprehension by connecting academic concepts to students' daily lives and cultural heritage. The integration of ethnoscience into educational materials has been empirically shown to improve students' scientific reasoning, critical thinking, and engagement with science content. In the context of Indonesian education, where cultural diversity is immense, ethnoscience offers a particularly valuable framework for developing locally situated and globally competent science learners.

The Rungkut district of Surabaya is home to a distinctive cultural heritage in the form of Kampung Kue Rungkut, a traditional cake-making community located at Jalan Rungkut Lor Gang II, which has been officially recognized as a culinary tourism destination since 2022. The activities of cake production at Kampung Kue Rungkut embed a rich array of authentic science concepts, particularly those related to matter state changes, as the process of

steaming cake batter involves the transformation from liquid to solid form through the application of heat energy. This ethnoscience context presents an exceptionally relevant and proximate source of scientific learning for elementary school students, as it connects formal scientific concepts to observable cultural practices within their own community. Khalel et al., (2023) affirm that integrating local wisdom into learning materials makes environmental education more relevant and effective by connecting academic content to students' real-life experiences and cultural heritage. The process of cake-making at Kampung Kue Rungkut thus serves as a living laboratory that can transform abstract science concepts into concrete and meaningful learning experiences for Grade 4 students. The potential of this ethnoscience context, however, has not been systematically exploited through the development of dedicated interactive digital learning media.

Despite the convergence of these factors, no existing study has systematically developed or empirically tested an e-flipbook grounded in the specific ethnoscience context of Kampung Kue Rungkut for the purpose of enhancing Grade 4 science literacy. This gap represents both a theoretical and practical limitation: theoretically, the integration of constructivist, ethnoscience, and digital media frameworks in this specific context remains unexplored; practically, teachers in urban Surabaya schools lack contextually grounded digital media for matter state change instruction aligned with Merdeka Curriculum Phase B outcomes. Against this backdrop, this literature review examines the theoretical and empirical foundations for developing such an e-flipbook, synthesizing recent research on science literacy, ethnoscience pedagogy, e-flipbook effectiveness, and local wisdom integration in science curricula. Bachri et al., (2024), demonstrated that ethnoscience-based digital modules effectively enhance students' cognitive and affective learning experiences by contextualizing content through familiar cultural environments. Rahmawati et al., (2025) further confirm that local wisdom-based flipbook instructional materials represent an innovative integration of digital technology with cultural heritage, rendering learning more relevant and effective for elementary school students. This review aims to consolidate the available evidence and provide a coherent theoretical framework for the proposed development of the e-flipbook media.

METHOD

This study employs a systematic literature review methodology to identify, evaluate, and synthesize the existing body of research relevant to ethnoscience-based e-flipbook development for science literacy enhancement in elementary education. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which provides structured guidance for conducting rigorous and transparent literature reviews. Academic databases searched include Google Scholar, ERIC, Scopus, and Indonesian Scientific Journal Portal (SINTA) using keyword combinations such as "ethnoscience-based learning," "e-flipbook science education," "science literacy elementary school," "local wisdom STEM," "interactive digital media primary science," and "Merdeka Curriculum science," both in English and Indonesian. Articles were selected based on the following inclusion criteria: peer-reviewed publications between 2022 and 2025, relevance to at least one of the four thematic areas of the review, focus on elementary or primary science education or digital media in education, and availability of full-text access. Exclusion criteria included literature reviews without primary empirical data (except foundational theoretical works), studies focused exclusively on secondary or higher education science, and publications outside the temporal boundary of the past three years.

The search process yielded an initial pool of 187 articles. After applying the inclusion and exclusion criteria through title and abstract screening, 94 articles were retained for full-text review. A further quality assessment using the Mixed Methods Appraisal Tool (MMAT) and a thematic relevance rubric resulted in the final selection of 42 articles that directly inform the four thematic areas of this review. Table 1 presents the distribution of selected literature by thematic area and methodology.

Table 1. Distribution of Selected Literature by Thematic Area

No.	Thematic Area	Number of Studies	Primary Methodology
1	Science Literacy in Elementary Education	11	Empirical / Survey / Experimental
2	Ethnoscience in Science Learning	12	R&D / Qualitative / Systematic Review
3	E-Flipbook as Digital Learning Media	10	R&D / Quasi-Experimental / Development
4	Local Wisdom Integration in Science Curricula	9	Qualitative / Mixed Methods
Total		42	

Source: Author's systematic literature review, 2025

The synthesis followed a thematic analysis approach in which recurring concepts, patterns, and gaps across the selected literature were identified and organized into coherent thematic clusters. Each article was coded according to its primary finding, methodology, population focus, and relevance to the development of ethnoscience-based e-flipbook media for science literacy enhancement. The quality and reliability of the review were strengthened through triangulation across multiple databases, independent screening by two reviewers, and the application of a standardized data extraction form. The resulting synthesis provides a comprehensive and evidence-based foundation for understanding the current state of knowledge in the field and for identifying the theoretical and practical rationale for the proposed instructional media development.

RESULT AND DISCUSSION

The systematic literature review identified four major thematic clusters that collectively provide the theoretical and empirical foundation for the development of an ethnoscience-based e-flipbook to enhance science literacy among Grade 4 elementary school students. The findings from each thematic cluster are presented below, supported by analytical tables and visual placeholders for figures.

1. Science Literacy in Elementary Education

The reviewed literature consistently affirms that science literacy represents a multidimensional competency encompassing three core performance strands as defined by the PISA framework: explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and scientific evidence. Hadjiali & Kolarova, (2024) identify four primary aspects of science literacy: the cognitive-epistemic dimension covering factual and conceptual knowledge; the functional dimension related to science-related skills; the social dimension involving the formation of attitudes toward science; and the metacognitive dimension encompassing self-regulation of scientific thinking. Fahri Haruna et al., (2024) further describe science literacy as composed of three foundational elements: a knowledge base, scientific thinking skills, and scientific attitudes and dispositions. Sun & Chan, (2025) report that science literacy development in early primary education is closely associated with students' language proficiency and reading comprehension skills, particularly their ability to decode scientific vocabulary and interpret informational texts.

Empirical studies on science literacy at the elementary level reveal a persistent gap between expected competency levels and actual student performance, particularly in Indonesian contexts. Suryanti et al., (2024) report that STEAM-Project-Based Learning functions as a catalyst for enhancing elementary students' science literacy

through authentic problem-solving activities. Yediyildiz & Ustun, (2024) demonstrate that socioeconomic factors significantly influence science literacy development, with students from advantaged backgrounds showing substantially stronger science literacy profiles. Hrynevych et al., (2022) emphasize that science literacy serves a socialization function beyond mere concept memorization, enabling students to interpret natural phenomena based on evidence and to critically evaluate information in their environment. Table 2 presents a comparative synthesis of science literacy indicators as identified across the reviewed studies.

Table 2. Synthesis of Science Literacy Indicators in Elementary Education

Science Literacy Dimension	Core Indicators	Relevant Sources
Cognitive-Epistemic	Factual and conceptual knowledge; epistemic understanding of how science generates claims	Hadjiali & Kolarova (2024); PISA 2025 Framework
Functional	Application of scientific skills; data interpretation; evidence-based reasoning	Sun & Chan (2025); Fahri Haruna et al. (2024)
Social	Scientific attitudes; critical evaluation of societal information; environmental awareness	Hrynevych et al. (2022); Snow & Dibner (2016)
Metacognitive	Self-regulation of learning; reflective scientific thinking; inquiry design	Suryanti et al. (2024); Yang et al. (2024)

Source: Synthesized from systematic literature review, 2025

2. Ethnoscience in Science Learning

Ethnoscience is defined as a disciplinary approach for exploring and articulating the distinctive knowledge systems of particular communities, bridging indigenous cultural wisdom with modern scientific understanding through the process of reconstructing local experiential knowledge into scientifically validated propositions Widarti et al., (2025). Wati et al., (2021) conducted a landmark literature review establishing ethnoscience as a pivotal educational approach in Indonesian science learning, particularly given the country's immense cultural and ethnic diversity. The reviewed literature identifies ethnoscience-based learning as operating through three principal stages: define, whereby learning objectives and assessment instruments are established in relation to local knowledge; design, whereby learning models and validation instruments are created; and development, whereby the learning product is tested and refined based on empirical evidence (Sudarmin, 2014, as cited in reviewed sources). Rizki et al., (2025) demonstrated that when ethnoscience is combined with technology such as augmented reality and virtual simulation, it yields significant improvements in student creativity, motivation, and understanding of complex scientific concepts.

The reviewed studies document a broad scope of ethnoscience applications in primary science education, ranging from ethnobiology and ethnobotany to ethnomedicine and ethnoastronomy. In the context of Indonesian elementary education, ethnoscience has been applied to contextualize learning about natural phenomena through locally recognized practices, food systems, agricultural knowledge, and traditional crafts. Bachri et al., (2024) demonstrated the effectiveness of an ethnoscience-based digital disaster learning module developed using the ADDIE model for Grade 4 students, reporting improvements in both cognitive and affective learning outcomes. Parmin et al., (2022) showed that prospective science teachers' ability to reconstruct indigenous knowledge of local culture using a scientifically rigorous approach scored an average of 88 out of 100, confirming the pedagogical viability of ethnoscience-based instructional design. Khalel et al. (2023) further affirm that integrating local wisdom into educational materials fosters critical thinking and problem-solving skills by connecting scientific reasoning to culturally embedded real-world experiences.

3. E-Flipbook as Interactive Digital Learning Media

The e-flipbook is a digital media format that presents educational content comprehensively and offers ease of access through various digital devices including smartphones, tablets, and computers (Qumillaila et al., 2022). Multiple reviewed studies confirm that e-flipbooks constitute a learning medium that is substantially more engaging than traditional textbook approaches, offering interactive, visually stimulating, and multisensory learning experiences particularly suited to tablet and smartphone environments (Usman et al., 2024). Trisnawati et al., (2024) highlight that e-flipbooks facilitate easier access to updated learning materials, support structured lesson planning, and promote collaborative learning between teachers and students. Evenddy et al., (2021) reported that a 3D flipbook e-learning module developed using the ADDIE model achieved satisfactory validation scores from both content and media experts, demonstrating moderate effectiveness in improving student learning outcomes. The development studies reviewed consistently employed the ADDIE or 4D models, establishing clear standards for validity, practicality, and effectiveness assessment of e-flipbook products.

The effectiveness of e-flipbooks in enhancing specific learning outcomes has been substantiated across multiple studies. Bunari et al., (2024) reported significant positive effects of flipbook learning media on student interest, learning motivation, and academic performance in a study involving middle school students. (Prihatiningtyas et al., 2025) demonstrated that a flipbook-based STEM Qur'an e-module significantly enhanced science literacy in Islamic boarding school contexts, recording high validity and practicality scores. Haryanto et al. (2020) found that e-worksheets developed using Kvisoft Flipbook software substantially improved students' science process skills, while Prasetyono et al. (2020) confirmed high validity and positive student response rates for flipbook-based digital learning materials. Table 3 presents a comparative analysis of e-flipbook development studies reviewed.

Table 3. Comparative Analysis of E-Flipbook Development Studies

Author & Year	Development Model	Subject Focus	N-Gain/Score	Key Finding
Evenddy et al. (2021)	ADDIE	Mathematics English	Moderate	Valid and effective for professional e-learning
Bunari et al. (2024)	Correlational	Science (General)	Positive correlation	Flipbook boosts motivation and learning outcomes
Prihatiningtyas et al. (2025)	R&D	STEM-Qur'an	High validity (>80%)	Enhances science literacy in Islamic school context
Rahmawati et al. (2025)	Instructional Design	IPAS (Primary)	High practicality	Local wisdom flipbook improves contextual relevance
Yuliarti et al. (2024)	R&D	Javanese Language	Positive	Improves learning outcomes through cultural integration

Source: Synthesized from systematic literature review, 2025

4. Kampung Kue Rungkut as an Ethnoscience Learning Context

Kampung Kue Rungkut represents a distinctive community-based ethnoscience resource embedded within the urban landscape of Surabaya. The traditional cake-making activities practiced by the community involve numerous observable science phenomena, most significantly the concept of matter state changes, where cake batter transitions from a liquid to a solid state under the influence of steam heat. From an ethnoscience perspective, the community's empirical understanding of how adonan (batter) transforms during the steaming process constitutes authentic indigenous scientific knowledge, acquired through generations of experiential learning and practical adaptation. The concept of kue lapis, the traditional layered cake most closely associated with Kampung Kue Rungkut, carries both scientific and philosophical significance: its layered structure embeds values of community, harmony, and perseverance within its physical characteristics (Fatahillah & Destrianingsih, 2013). This dual scientific and cultural

significance makes kue lapis an exceptionally suitable subject for ethnoscience-based science learning in the elementary school context.

The scientific analysis of kue lapis production encompasses multiple dimensions of elementary-level science content. Biologically, the ingredients including rice flour and coconut milk involve organic materials with distinctive properties. Physically, the steaming process exemplifies heat transfer, matter state change, and energy transformation, all of which align precisely with Phase B learning outcomes in the Merdeka Curriculum. Chemically, the gelatinization of starch when heated constitutes a scientifically verifiable process that can be reconstructed from indigenous knowledge into formal scientific understanding. Mahendra & Hasanah, (2023) demonstrate through their study of the ethnomathematics of kue lapis pelangi that traditional cake-making practices embed sophisticated mathematical and scientific reasoning that can be systematically reconstructed for educational purposes. The availability of actual cake-production demonstrations at Kampung Kue Rungkut further provides the opportunity for contextual learning experiences that bring science content to life for Grade 4 students.

Discussion

The synthesis of literature across the four thematic areas reveals a compelling and coherent case for the development of an ethnoscience-based e-flipbook grounded in the Kampung Kue Rungkut context to enhance science literacy among Grade 4 elementary school students. The foundational challenge identified across the reviewed literature is the persistent gap between science literacy expectations as articulated in national curricula and international benchmarks and the actual competency levels demonstrated by Indonesian elementary school students. Yang et al., (2024) confirm that higher science literacy levels enable individuals to engage more deeply with and critically evaluate scientific information, while students with lower science literacy struggle to move beyond surface-level comprehension of factual content. Hadjali & Kolarova, (2024) establish that science literacy encompasses cognitive, functional, social, and metacognitive dimensions that require holistic instructional approaches beyond conventional textbook-based teaching. The identified science literacy gap thus underscores the urgency of developing instructional media that can simultaneously address content comprehension, scientific reasoning, and culturally situated engagement with science learning in the elementary context.

Ethnoscience emerges from the reviewed literature as a theoretically robust and empirically validated approach for making science education more contextually meaningful for elementary school students. Wati et al., (2021) establish that ethnoscience bridges traditional cultural wisdom with modern scientific learning, particularly in Indonesia where cultural and ethnic diversity creates a rich landscape of indigenous knowledge systems. Rizki et al., (2025) demonstrate that ethnoscience combined with technology such as augmented reality enhances student creativity and motivation for learning abstract physics concepts, providing direct evidence for the motivational value of culturally contextualized science instruction. The constructivist theoretical foundation underlying ethnoscience-based learning aligns with Piaget's theory of cognitive development, which emphasizes that elementary school children in the concrete operational stage require tangible, observable, and contextually familiar experiences to build meaningful scientific understanding (Nurhasnah et al., 2024). The ethnoscience context of Kampung Kue Rungkut provides precisely this kind of observable, familiar, and culturally resonant scientific experience for Grade 4 students in the Surabaya context.

The e-flipbook format has been established through multiple development studies as a highly effective medium for delivering ethnoscience-based science content to elementary school students. Evenddy et al., (2021) confirmed the effectiveness of 3D flipbook e-learning modules developed using the ADDIE model, demonstrating that the multimedia integration capabilities of e-flipbooks allow for dynamic visualization of otherwise abstract content. Bunari et al., (2024) reported a significant positive relationship between flipbook media use, student

learning interest, and learning motivation, indicating that the interactive and visually engaging format of e-flipbooks sustains student attention and promotes deeper engagement with learning content. Prihatiningtyas et al., (2025) specifically demonstrated the science literacy-enhancing potential of flipbook-based e-modules, reporting high validity and practicality scores in their development of a STEM-integrated e-flipbook. The technological affordances of the e-flipbook format, including the ability to embed video demonstrations of cake-making processes, interactive quizzes, and navigable content structures, align precisely with the needs of science literacy instruction focused on phenomenon explanation, scientific inquiry, and data interpretation.

The integration of local wisdom from Kampung Kue Rungkut into the e-flipbook design directly addresses the pedagogical limitation of conventional science learning materials, which present science concepts in decontextualized and abstract forms. Bachri et al., (2024) demonstrated that ethnoscience-based digital modules that leverage familiar local contexts, such as the volcanic ecosystem of Mount Semeru, substantially improve students' cognitive engagement and their ability to connect scientific concepts to their lived environment. Parmin et al., (2022) confirmed that students who learn science through indigenous knowledge reconstruction demonstrate stronger conceptual understanding than those taught through conventional methods, as the process of bridging cultural knowledge and scientific principles deepens conceptual processing. The kue lapis production process, as documented through field observation at Kampung Kue Rungkut, provides concrete and observable demonstrations of matter state changes through steaming, heat transfer mechanisms, and the physical and chemical transformations of food ingredients, all of which correspond directly to Phase B science learning outcomes in the Merdeka Curriculum. Rahmawati et al., (2025) affirm that local wisdom-based flipbook materials improve contextual relevance and student comprehension in elementary social and science studies, providing direct evidence for the approach proposed in the current study.

The theoretical alignment between constructivist learning theory, ethnoscience pedagogy, and the interactive affordances of e-flipbooks creates a particularly powerful framework for science literacy enhancement. Constructivism, as articulated through Piaget's theory and elaborated by Vygotsky's sociocultural perspective, posits that learners build knowledge through active engagement with meaningful experiences and that learning is most effective when it connects new information to existing cognitive schemas (Nurhasnah et al., 2024). Ethnoscience-based learning operationalizes this constructivist principle by using students' existing cultural knowledge as the foundational scaffold upon which formal scientific understanding is built. Istianah, (2023) emphasizes that teachers functioning as facilitators in student-centered science learning promote exploration and self-discovery, which are essential processes for science literacy development. The e-flipbook format further supports constructivist learning by providing interactive navigation features that allow students to explore content at their own pace, engage with embedded multimedia representations, and connect conceptual explanations to observable phenomena through video documentation of Kampung Kue Rungkut cake-making activities.

The assessment framework for the proposed e-flipbook development is grounded in established quality criteria that encompass validity, practicality, and effectiveness dimensions as specified by (Plomp & Nieveen, 2007). Validity in this context refers to the alignment of e-flipbook content with Phase B science learning outcomes, the accuracy of ethnoscience reconstruction from indigenous Kampung Kue Rungkut practices to formal scientific concepts, and the appropriateness of science literacy indicators embedded in the media's assessments. Practicality encompasses the accessibility of the digital medium across available devices, the clarity of the user interface for Grade 4 students, and the ease of classroom integration for teachers. Effectiveness is measured through the normalized gain (N-Gain) formula developed by Hake, (1998) which quantifies the improvement in science literacy scores from pretest to posttest, with a minimum threshold of $g \geq 0.30$ indicating medium effectiveness. Suryanti et al., (2021) demonstrated that ethnoscience-based science learning in elementary schools yields positive outcomes for science literacy when media are designed with contextual relevance, interactive features, and clear alignment to curriculum

objectives. This comprehensive assessment framework ensures that the developed e-flipbook will be held to rigorous quality standards throughout the development cycle.

The Merdeka Curriculum's emphasis on project-based and contextual learning creates a particularly conducive environment for the implementation of ethnoscience-based e-flipbook media. The curriculum's flexibility for teachers to adapt content to local contexts and student characteristics aligns directly with the ethnoscience approach's core principle of using community knowledge as a learning resource. Permendikdasmen Number 10 of 2025 establishes that graduates of elementary education should be capable of productive behavior, innovation, and the formulation of solutions to problems in their surrounding environment, competencies that are precisely what ethnoscience-based science literacy instruction cultivates. Komang et al., (2025) confirm that primary science education under the Merdeka Curriculum is designed to develop students' scientific reasoning, practical skills, and appreciation for natural phenomena in a manner consistent with Phase B competency targets. The development of an ethnoscience-based e-flipbook in the Kampung Kue Rungkut context thus represents not merely an instructional media innovation but a curriculum-aligned response to the documented science literacy challenges facing Grade 4 students in Indonesian elementary schools.

The synthesis of reviewed literature identifies several critical design principles that should guide the development of the ethnoscience-based e-flipbook. First, the media must present ethnoscience content that accurately reconstructs indigenous Kampung Kue Rungkut knowledge into scientifically valid representations of matter state changes, heat transfer, and physical transformation processes. Second, the interactive features must be designed to scaffold all three PISA science literacy competencies: explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and scientific evidence. Third, the visual design must be appropriate for the cognitive and aesthetic preferences of 10 to 11-year-old students while maintaining scientific accuracy and cultural authenticity. Fourth, the embedded e-LKPD (electronic student worksheets) must provide structured opportunities for students to practice science literacy skills in the context of Kampung Kue Rungkut phenomena. Qumillaila et al., (2022) demonstrated that e-flipbooks developed for environmental education effectively promoted digital literacy among elementary students in rural Indonesian contexts, confirming the medium's versatility and accessibility across diverse educational settings. These design principles, grounded in the reviewed evidence base, provide a systematic framework for developing an e-flipbook media that is simultaneously valid, practical, and effective for science literacy enhancement.

Several limitations should be acknowledged. First, the review is limited to 2022–2025 publications, potentially excluding influential earlier foundational studies. Second, most included studies were conducted in Indonesian contexts, which may limit the international generalizability of findings. Third, since no empirical testing of the proposed e-flipbook has been conducted, effectiveness claims remain theoretical and analogical. Fourth, grey literature and unpublished theses may carry relevant findings not captured in the databases searched. These limitations underscore the importance of proceeding to empirical ADDIE-based development to generate context-specific validity, practicality, and effectiveness data.

For classroom teachers, this review provides evidence-based justification for supplementing Phase B IPAS instruction with locally developed digital media that connect matter state change concepts to observable Kampung Kue Rungkut practices. For curriculum developers and school principals, ethnoscience mapping should be embedded as a mandatory first step in school-level instructional material development under the Merdeka Curriculum. For teacher training institutions, pre-service programs should include both ethnoscience reconstruction competencies and digital media design skills to equip future teachers to create culturally grounded e-flipbooks. For policymakers, the convergence of reviewed evidence supports scaling locally contextualized e-flipbook development through Platform Merdeka Mengajar as a cost-effective strategy for distributing culturally responsive instructional resources across Indonesia's diverse regional contexts.

CONCLUSION

This systematic literature review has established a robust theoretical and empirical foundation for the development of an ethnoscience-based e-flipbook grounded in the Kampung Kue Rungkut context to enhance science literacy among Grade 4 elementary school students. The novelty of the proposed development lies in its integration of three convergent elements that have not previously been combined in a single instructional product: the specific ethnoscience context of Kampung Kue Rungkut as a matter state change learning resource, the interactive digital affordances of e-flipbook media, and the Phase B science literacy framework of the Merdeka Curriculum. The reviewed literature demonstrates that science literacy requires holistic instructional approaches addressing cognitive, functional, social, and metacognitive dimensions, while ethnoscience-based learning provides a culturally responsive framework for connecting formal science concepts to students lived cultural experiences. The e-flipbook format has been validated across multiple development studies as an effective, accessible, and engaging medium for delivering contextually rich science content aligned with PISA science literacy competencies.

The convergence of ethnoscience pedagogy, constructivist learning theory, and the interactive affordances of digital e-flipbook media presents a compelling rationale for the development of the proposed instructional product. The traditional cake-making practices of Kampung Kue Rungkut, particularly the production of kue lapis, embed authentic and observable instances of matter state changes and energy transformation that directly correspond to Phase B learning outcomes of the Merdeka Curriculum. Future research should proceed with the development, validation, and empirical testing of the ethnoscience-based e-flipbook using the ADDIE model, measuring validity through expert panel evaluation, practicality through teacher and student response instruments, and effectiveness through normalized gain analysis of science literacy pretest and posttest scores.

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