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Eco-marine reading literacy: A conceptual framework for environmentally contextualized multimodal literacy in global EFL education

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ABSTRACT

Purpose — The present study proposes a conceptual framework to add environmental awareness to EFL reading literacy in terms of eco-marine reading literacy. The concepts involved are reading literacy, eco-literacy, place-based education, culturally sustaining pedagogy, the Cognitive Theory of Multimedia Learning, and multimodality theory.

Design/methodology/approach — Designed with systematic theoretical analysis, the research operates from definition to construct an entire model on theory alone that links cognitive reading, ecological content alignment, contextual-cultural basis, and multimodal representation.

Findings — This analysis shows that these theoretical approaches are not at odds but speak to different structural aspects of literacy. Reading literacy explains cognitive processes of comprehension, eco-literacy content oriented toward sustainability, contextual pedagogies orient learning toward local cultural realities, and multimedia theories describe how meaning is mediated in digital environments. The proposed EMRL framework combines these dimensions into a single lens through which literacy is understood as both a cognitive and socio-ecological practice.

Originality/value — The proposed framework advances a theoretical foundation for bridging gaps between language education, and it is flexible as well as susceptible to adaptation across a range of education. This study helps fill a gap in EFL literacy by adopting an ecologically situated learning approach to interpret digitally enhanced 21st-century literacy.

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Introduction

Environmental degradation, climate instability and coastal vulnerability are no longer fringe global issues; they are structural conditions of contemporary education. Schools in diverse contexts have been increasingly accepting of sustainability as a critical aspect of twenty-first-century learning (O'Halloran et al., 2023). But inside English as a Foreign Language setting, reading instruction tends to be disengaged from ecological realities (McVee et al., 2023). Regarding textbooks, culturally neutral or globally generic themes continue to be preferred over environmental awareness and contextual relevance in exchange for linguistic accuracy and reading comprehension strategies (Pannatier & Betrancourt, 2024). This disconnection belies a deeper theoretical fragmentation within literacy scholarship: cognitive models of reading do not converge with ecological education, culturally relevant pedagogy, and multimodal digital design (Rahmania, 2024).

While international frameworks developed and theorized on hereby scholars of literacy such as Kintsch (1988) frame reading literacy to include the ability to understand, interpret, evaluate and reflect upon texts. These models highlight the cognitive processes of decoding, inference-making, building upon a background of prior learning about ways to read and text types, and critical evaluation (Li et al., 2023). Although these frameworks provide rigorous bases for measuring comprehension outcomes, they are largely content-free. Reading literacy articulates how texts are processed, but does not itself specify which kinds of text should be prioritized in relation to global sustainability challenges (Rosado-castellano & Martín-sánchez, 2023).

In contrast, eco-literacy seeks to place the development of environmental awareness and sustainability consciousness as primary objectives of education. Eco-literacy focuses on systems thinking, ecological interdependence and the ethical responsibility toward the natural world (Nikola et al., 2025). Culture, Ecology and Eco-literacy issues largely fall within science and environmental education (Mcruer et al., 2025). Its role in EFL reading is still under-theorized. Where environmental issues are addressed in language classrooms, they are often approached as thematic add-ons rather than structurally integrated into literacy models. Simultaneously, scholars focused on Place-Based Education (PBE) and Culturally Sustaining Pedagogy (CSP) state that learning has meaning rooted in visible contexts, lived experiences, and cultural identities (Yemini et al., 2025). PBE stresses the educational value of linking curriculum to place based realities, while CSP builds on this by arguing for the conservation and dynamic continuity of cultural identities within schooling (Elbaz, 2023). However, these frameworks are seldom brought into contact with cognitive models of reading in EFL research even though they would be relevant for contextualized literacy. Literacy is normally understood as cognitive skill developing, or as sociocultural practice, rarely both and nowhere an integrated system spanning the two.

Compounding this is the rise of digital learning. So today reading is growingly multimodal mediated by visual, auditory, and interactive information that accompanies the textual cues (Zhang, 2025). According to the Cognitive Theory of Multimedia Learning (CTML), verbal and visual information is processed in two different channels (one for each modality) with a limited cognitive capacity (Chaves-Yuste & De-La-Peña, 2025). On the other, multimodality theory stresses how different semiotic modes interact in creating meaning (Tsankov, 2025). Despite this rich and growing body of scholarship, few literacy frameworks provide a systematic way to integrate cognitive reading processes, ecological

content, contextual pedagogy and multimodal digital design into an integrated theoretical construct. Such integration is thus a missing piece of the puzzle. Environmental education, contextual pedagogy, literacy theory and multimedia design remain largely parallel conversations. Consequently, EFL reading instruction may remain decontextualised, environmentally unconcerned and under-theorized in a digital way. Solving this disintegration demands a fresh integrative framework that could connect these features together.

In response to this liminal status, this paper introduces Eco-Marine Reading Literacy (EMRL) as a conceptual framework synthesizing cognitive reading theory with ecological awareness, culturally grounded contextualization, and multimodal digital mediation in EFL education. While "marine" reflects origins in coastal contexts, the framework is framed as transferable to diverse environmental settings globally. But EMRL is not just about infusing environmental themes into reading material; it reimagines literacy as a vibrant intersection of cognition, ecology, culture and digital representation.

The cognitive basis of EMRL is reading literacy. Based on OECD definitions and the Construction-Integration model, reading comprehension is understood as constructing meaning from text information and integrating this meaning with prior knowledge (Rappleye et al., 2024). This process includes literal meaning, inferential thinking, and critical evaluation (Fauziah & Irawati, 2020). These cognitive dimensions are indispensable as long as one believes in literacy measures without comprehension, that are devoid of valid academic metrics (Yu et al., 2013). Nevertheless, the sociocultural or ecological orientation of literacy practice is not determined by cognitive models alone (Martínez Zepeda, 2023). EMRL maintains reading literacy as a structural core, but opens up its epistemic orientation.

Regarding the eco-literacy, the literature-based environmental content and focus of the EMRL framework. It reframes literacy, not just as the tools to read words on a page, but as the very ability to read ecological systems and interdependent relationships between people and nature (Hasrina et al., 2024). Eco-literacy, thus, alters the nature of textual engagement in EFL contexts (Saifulloh et al., 2025). Reading productions are no longer free from ideological language but as instruments for a critical nature analysis (Lorenz et al., 2021). Text types relevant to the day-to-day life of students: environmental story arcs, informational text about sustainability and argumentative pieces on ecological policy all provide important opportunities through which learners read about issues facing planet earth while simultaneously improving reading comprehension (van der Beek & Lehmann, 2024). As such, eco-literacy encodes not only the thematic orientation of texts but also the interpretive depth through which learners become immersed with EMRL.

Eco-literacy inserts an ecological orientation into the framework by positioning texts as vehicles for examining the relationship between humans and the natural environment, as well as issues of sustainability and ecological responsibility. However, because the present study is situated in a coastal context, this ecological orientation also needs to be extended to marine literacy. Marine literacy narrows the ecological focus to oceans, coastal ecosystems, marine resources, and human interactions with coastal environments. In this sense, eco-literacy and marine literacy are treated as complementary perspectives: eco-literacy provides the broader sustainability foundation, while marine literacy gives the framework a more specific coastal and oceanic focus. Their integration forms the basis for what this study

proposes as *eco-marine literacy*, a literacy orientation that connects language learning with ecological awareness and marine-related environmental understanding.

This orientation towards ecology is deepened with the necessary insight offered by Place-Based Education (Elbaz, 2023) and Culturally Sustaining Pedagogy (Galappaththi et al., 2025). Both perspectives suggest that learning without relationship to lived experience threatens to become abstract and increasingly distant from learners' identities. EMRL places ecological texts in culturally and geographically salient contexts, inviting learners to read environmental challenges through their own social and cultural realities (Widianto & Pusse, 2025). Contextualization of that nature enhances engagement and Inform meaning-making more authentically (Chen et al., 2025). Essentially the CSP perspective ensures that English is not a displacing force but rather used as a vehicle through which learners express and re-contextualize their cultural and ecological knowledge in global conversations (Carpio de los Pinos et al., 2026). In this view, literacy is a dialogic practice where local experience and global language interact in ways that construct meaning.

Attention to meaning-making and learning in the digital sphere is also a pertinent challenge within contemporary EFL contexts with its ecological and contextual aspects of language instruction. Thus, EMRL combines concepts from the Cognitive Theory of Multimedia Learning and multimodality theory (Alshaikh et al., 2024). CTML offers design principles that can guide the effective development of multimodal materials, elucidating how they should be crafted according to cognitive processing mechanisms, allowing visual and auditory materials to complement each other rather than further bombard learners with excessive information (Bledsoe & Simmerok, 2014). Building on this idea, multimodality theory explains that we make meaning not just through writing language but with many semiotic resources working together: image and sound, as well as those found in digital interaction (e.g., links). Thus, within the EMRL framework, digital media have an epistemic and not decorative function. Narrative audio explanations and interactive prompts scaffold comprehension by immersing learners in ecological contexts alongside visual representations of marine ecosystems (Bahanshal, 2023).

No single framework has integrated any of these theoretical traditions, despite their conceptual strength. Reading literacy affords detailed descriptions of cognitive comprehension processes but typically without an ecological orientation. Eco-literacy can prioritize environmental awareness but does not provide a clear operationalization of what literacy practices might look like in EFL learning environments. Contextual pedagogies, especially problem-based education and culturally salient pedagogy (Messner, 2025), highlight cultural principles and identity formation but rarely frame your reading comprehension as cognitive knowledge building. On one hand, theories of multimedia learning and multimodality explain how information can be processed and represented through digital media (Mayer, 2005), yet usually do not prescribe types of ecological or culture content to inform literacy instruction. Consequently, these theoretical domains are conceptually fragmented despite their contemporary relevance to education.

This fragmentation constitutes an important theoretical gap. What is still missing to be conceived is a structured framework for the circuitry of cognitive literacy processes—ecological content orientation, contextual-cultural groundedness, multimodal representation transcends the complicated tangents into a singular construct. This study presents the Eco-Marine Reading Literacy framework with the goal of addressing just that

gap by bridging these theoretical perspectives into a coherent system whereby each makes its own but interdependent contribution to shaping environmentally contextualized literacy within EFL education.

As a conceptual inquiry aimed at theoretical integration and model construction, this research formulates the following research questions: (1) How can cognitive reading literacy, eco-literacy, contextual pedagogies, and multimodal design be theoretically integrated into a coherent EFL literacy framework?; (2) What structural components define Eco-Marine Reading Literacy as a unified conceptual model?; (3) How does the proposed framework address existing fragmentation within EFL literacy and sustainability education?; and (4) In what ways can Eco-Marine Reading Literacy function as a transferable model for environmentally contextualized literacy in global EFL settings?

Method

Research design

The aims of this study are to apply the theoretical interpretative method of conceptual integration and to formulate a coherent theory by proposing the framework of environmentally contextualized literacy in EFL education (Ouyang et al., 2025). The study does not employ field data collection or statistical analysis, instead it uses systematic theoretical analysis and synthesis to develop a novel conceptual model (Shad & Lai, 2015). This approach is not given for the sake of summarizing existing studies; it intends to interconnect and rearrange theoretical thoughts that have been produced in relatively separate strands of work in such fields as literacy education, environmental education, cultural pedagogy and multimedia learning (Jabareen, 2009). This study aims to provide a framework on ecological awareness through contextual learning and multimodal representation in EFL literacy instruction by synthesizing the above-mentioned perspectives.

Data source

This process began with the identification of a few key theoretical traditions that are relevant to the study's focus (Zanni & Frydman, 2005). Six theoretical domains were chosen based on their strong conceptual contribution to literacy and education: reading literacy, eco-literacy, place-based education (PBE), culturally sustaining pedagogy (CSP), cognitive theory of multimedia learning (CTML) and multimodality theory. Two primary considerations guided the selection of these theories (Liu et al., 2026).

Data analysis

The analysis was conducted in six steps. First, each theory was selected based on its direct contribution to literacy learning, including cognitive processing, environmental context, sociocultural context, and knowledge representation through different media. Second, the theories were examined for conceptual accuracy by referring to foundational and widely cited works. Third, the relevant theories were mapped to identify their main focus, key concepts, and relevance to literacy education. Fourth, the theories were compared using common conceptual lenses, such as learning and meaning-making, knowledge construction, teaching practices, and types of literacy. Fifth, the comparison helped identify alignments, differences,

and gaps among the theories. For example, reading literacy explains comprehension, while eco-literacy emphasizes sustainability. Finally, the insights were integrated into one framework guided by functional differentiation and non-hierarchical alignment, allowing each theory to contribute equally to a holistic understanding of environmentally contextualized literacy learning in EFL classrooms.

This involves synthesizing the resulting conceptual framework that connects cognitive, ecological, cultural and multimodal approaches to literacy education. The model is not held to have been empirically tested. Instead, the framework is meant to serve as a theoretical underpinning for future research and instructional design. By clarifying the relationships between these theoretical traditions, this study provides a framework for developing pedagogical approaches, curricular materials, and any future empirical studies of environmentally contextualized literacy.

Findings and discussion

Integrating cognitive, ecological, contextual, and multimodal dimensions in EFL literacy

The blending of these fields into one coherent theoretical conceptual framework for EFL literacy that we have conducted in this study shows that there are many traditions in literacy and education scholarship and research that extend somewhat critically at the same time, but nonetheless offer a way to align with each other. The analysis shows that cognitive reading literacy, eco-literacy, contextual pedagogies, and multimodal learning theories can be seen not as competing perspectives on literacy but rather as complementary dimensions that address different aspects of literacy learning. Rather than being viewed as disparate approaches to understanding meaning-making in literacy education, these traditions function on separate but interconnected dimensions of literacy development.

Reading literacy sets the cognitive foundation by explaining how learners process written information through decoding, inference-making, interpretation, and critical reading. Eco-literacy introduces an ecological orientation by positioning texts as vehicles for examining relationships between humans and the natural environment, as well as issues of sustainability and ecological responsibility. Recent advances in reading comprehension demonstrate that higher-order processes, such as inference-making and critical evaluation, are essential for deep textual integration and knowledge construction (Duke et al., 2021). Given the coastal orientation of the present study, this ecological perspective is further extended through insights from marine literacy, which emphasize understanding oceans, coastal ecosystems, marine resources, and human interactions with marine environments. In this way, eco-literacy provides the broader sustainability framework while marine literacy contributes a more specific focus on coastal and marine contexts. The integration of these two perspectives forms the ecological dimension of the proposed framework.

Contextual pedagogies, represented by Place-Based Education and Culturally Sustaining Pedagogy, situate literacy within lived experiences, cultural identities, and community knowledge systems. Multimedia learning theory and multimodality, on the other hand, explain how meaning is represented and mediated through combinations of text, image, sound, and interactive digital formats. Culturally sustaining frameworks highlight the necessity of grounding literacy practices in students' linguistic and cultural resources to foster meaningful community connection and academic engagement (Paris & Alim, 2017). Each

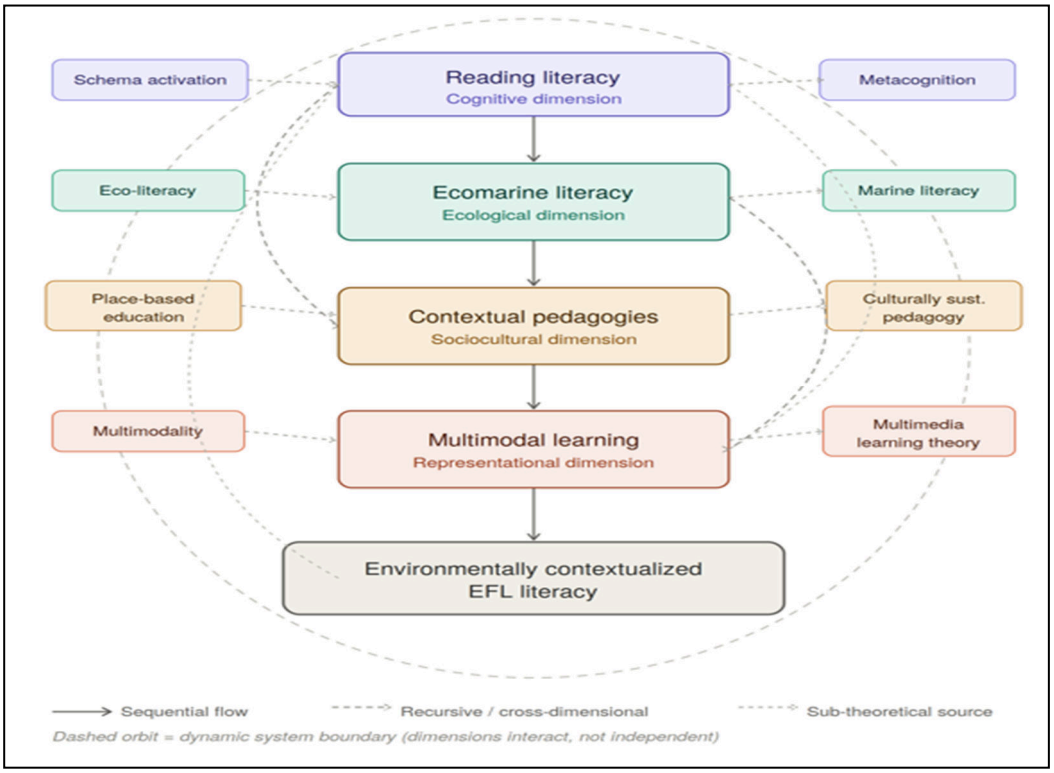
perspective contributes a distinct yet complementary role, allowing cognition, environmental understanding, sociocultural relevance, and multimodal representation to function as interconnected dimensions of literacy learning. This convergence helps reconcile the long-standing divide between cognitive models of reading and sociocultural theories of literacy by embedding comprehension processes within environmental and cultural contexts that are increasingly mediated through digital modalities.

The integration occurs through a sequential and interconnected process. Learners first engage cognitively with texts through reading literacy processes. The content of those texts is informed by ecological perspectives derived from both eco-literacy and marine literacy, foregrounding sustainability, environmental awareness, and coastal–marine understanding. Understanding is further strengthened through contextual pedagogies that connect the content to local culture and community experiences. Finally, multimodal and multimedia resources enrich the learning experience by presenting information through multiple semiotic modes. In this way, cognition, ecological content, sociocultural relevance, and multimodal representation operate together as mutually reinforcing dimensions of EFL literacy rather than as separate theoretical perspectives. By aligning cognitive strategies, localized environmental contexts, and multimodal representations, integrated literacy models significantly enhance learners' communicative competence and critical awareness in EFL settings (Mayer, 2019).

Based on the theoretical synthesis conducted in this study, an integrated conceptual framework was developed to illustrate the relationships among the cognitive, ecological, sociocultural, and representational dimensions of EFL literacy. The framework is demonstrated in Figure 1.

Figure 1

Integrated Theoretical Conceptual Framework for Environmentally Contextualized EFL Literacy



As illustrated in Figure 1, the framework integrates reading literacy, eco-marine literacy, contextual pedagogies, and multimodal learning as complementary dimensions of EFL literacy. While the model presents a sequential pathway from cognitive processing to literacy outcomes, the dashed connections indicate recursive interactions among dimensions and their underlying theoretical sources. This structure highlights that literacy learning emerges from the dynamic interplay of cognitive, ecological, sociocultural, and representational processes rather than from any single theoretical perspective.

Structural components of eco-marine reading literacy

It also allows for this conceptual synthesis to be integrated into a single four-domain framework referred to as Eco-Marine Reading Literacy (EMRL). At its core is the cognitive reading mechanism, which holds on to established models of comprehension and interpretation. Based on the construction–integration perspective of reading, activating textual information and merging it with prior knowledge are essential for learners to build meaning. Recent empirical applications of the construction–integration model confirm that reader comprehension improves substantially when texts directly activate and build upon domain-specific prior knowledge (Kendeou et al., 2020). At the same time, integral processes of literal comprehension, inferential and critical reasoning, ensure there is intellectual rigor in literacy development that has a measurable outcome. This cognitive dimension is missing; thus, literacy could become thematic engagement with no analytic depth.

The second domain is ecological content orientation, which places reading materials into the sustainability discourse. Rather, within the EMRL framework, our texts are not neutral linguistic artefacts but meaningful carriers of implicitly held environmental knowledge. Reading materials can be texts that narrate marine ecosystems, texts that describe environmental processes, or argumentative discourse about sustainability problems. Through these texts, learners experience environmental issues not as an isolated science lesson but through interpretive reading. This method transitions reading from a strictly linguistic endeavor into a channel through which ecological consciousness and environmental stewardship can be examined.

The third domain involves the contextual-cultural grounding. Grounded in both place-based and culturally sustaining pedagogies, this pillar guarantees that the ways we teach literacy will reflect learners' lived experiences and cultural identities. In order to connect Global themes of sustainability to their everyday realities, Environmental themes are literally interpreted from locally meaningful contexts. In this way, English is not only a distant global tongue but the means by which students share and construct ecological knowledge relevant to their own settings. Consequently, literacy is both a cognitive practice and a sociocultural act that affirms identity as it engages with global environmental issues.

The fourth domain is multimodal design. Today, literacy increasingly takes place in digital contexts where meaning is expressed across multiple representational modes. Under the direction of the Cognitive Theory of Multimedia Learning and multimodality theory, this domain describes how textual information works in synergy with visual/multimodal, auditory/audio-narrative, and interactive components to promote comprehension. Good design ensures that the multimedia elements support understanding instead of exceeding cognitive capacity. Images, diagrams, audio narration and interactive prompts do not

function as decorative additions but rather as semiotic resources that deepen interaction with the ecological content. Coupled with cognitive reading processes and contextual knowledge, multimodal mediation enables learners to experience environmental narratives in rich layers of meaning. These four domains constitute an interdependent system so that literacy can be considered to be structurally complete when cognition, ecological content, cultural grounding and multimodal representation are aligned.

Addressing fragmentation in literacy and sustainability education

A further key outcome of the theoretical synthesis is its capacity to ameliorate fragmentation in several domains of educational research. Traditional literacies scholarship has often been characterized by a divide between cognitive approaches that foreground comprehension processes, and sociocultural perspectives that focus on context, identity, and lived experience. The EMRL framework addresses this gap by tapping into cognitive reading processes through culturally and environmentally situated texts. Learners do not just practice their comprehension skills in isolation, putting them to work on texts linked to ecological realities and experiences in the community such that cognition and context operate as mutually supportive processes.

The framework also highlights the long-acknowledged divide between environmental education and language education. Eco-literacy projects, for example, have typically been nested within science curricula, and language education has mainly equated linguistic competence with formal knowledge of grammatical structures. Through infusion of environmental themes into reading instruction, EMRL bridges sustainability discourse and processes for learning a language. This encourages students to connect with and respond to ecological issues through interpretation and discussion in English, turning awareness of the environment into a core part of learning to read and write.

The second contribution concerns the role of digital media in literacy education. While classroom teachers rely heavily on digital technologies in their classrooms, they often do so without a clearly articulated theoretical perspective about how multimedia supports cognitive processing. The EMRL framework proposes that the Cognitive Theory of Multimedia Learning does not consider multimodality, which should be taken into account to ensure that digital environments foster understanding rather than just present good materials. Multimedia features follow cognitive principles so that learners can process ecological content through varied representational pathways while maintaining conceptual coherence.

The model also reconciles global languages learning with local culture and identity. As a global lingua franca, English has sometimes been criticized for contributing to cultural displacement or homogenization. However, under an EMRL framework, English serves as a vernacular to be able to see and hear local ecological knowledge and cultural experience. Culturally sustaining pedagogies allow students to address environmental issues while remaining grounded in their own cultural contexts. Literacy thus serves as a juncture where global communication, rather than competing with, is rich in local identity. By synthesizing indigenous marine wisdom with transnational discourse, EMRL bridges the historical divide between instrumental language proficiency and place-based ecological consciousness,

ensuring that sustainability education is neither culturally detached nor semantically isolated.

Transferability of the eco-marine reading literacy framework

Finally, the biggest outcome is understanding that EMRL project can apply to other areas beyond the environment. While the term *marine* refers to the environmentally oriented genesis of the conceptual framework, its structural architecture should not be limited to coastal ecosystems. The ecological domain can be easily tailored to various environmental contexts, such as forests, agricultural systems, urban sustainability challenges, or climate resilience issues. The structural congruence between cognitive reading processes, ecological orientation, contextual positionality, and multimodal representation remains constant across contexts.

This flexibility is enabled by a modular architecture. The core cognitive reading processes do not differ based on context (e.g., printed text, screens, etc.) and that ensures literacy instruction continues to focus on comprehension, inference and evaluation. This domain of ecological content can be adapted to align with the environmental realities nearest learners' communities. This foundation contextualizes the local literacy activities in terms of local knowledge, traditions, and identities. On the other hand, multimodal design mechanism tailoring itself according to course technology infrastructures and digital access conditions where education is located.

This flexibility makes EMRL more of a conceptual model than a step-by-step instructional guide. It offers structural guidance for embedding environmental awareness in literacy education while also enabling teachers and curriculum designers to adapt content and media based on local conditions. The framework is also applicable at different levels of education. Ecological narratives in primary education may prioritize descriptive understanding and basic comprehension. For secondary or tertiary levels, more sophisticated texts and analytical discussion regarding sustainability can play a role in promoting critical literacy. The four-domain architecture remains the same across these frameworks, allowing literacy instruction to retain coherence across the changing topography of different learning environments.

By means of this structural adaptability, Eco-Marine Reading Literacy becomes more than just a global pedagogic innovation but also a generalized contextual literacy conceptual framework for the planetary popularization of the global EFL (English as a Foreign Language) education. By drawing connections among cognitive processes, environmental content, cultural grounding, and multimodal representation, the framework provides a cohesive model for how literacy education can interact with ecological and digital realities in modern learning environments. This contextual flexibility allows educators and curriculum designers across disparate socioeconomic and geographic strata to recalibrate the framework according to their immediate ecological imperatives without compromising its pedagogical rigor. As such, EMRL functions not as a rigid pedagogical mandate, but as an adaptable blueprint that empowers diverse learning communities to translate localized environmental concerns into impactful, globally audible discourse.

To illustrate the structural alignment among the theoretical traditions discussed above, Table 1 synthesizes their respective conceptual contributions and positions them within EMRL framework.

Table 1

Theoretical Synthesis Underlying the Eco-Marine Reading Literacy Framework

Theoretical domain	Core focus	Key conceptual contribution	Structural role in EMRL	Dimension addressed
Reading literacy	Cognitive processes of comprehension	Explains how readers decode, infer, interpret, and critically evaluate texts	Provides the cognitive reading core ensuring comprehension depth and measurable literacy outcomes	Cognitive processing
Eco-literacy	Environmental awareness and sustainability	Positions texts as tools for interpreting ecological systems and human–environment relationships	Defines the ecological content orientation guiding the thematic focus of reading materials	Ecological orientation
Place-based education (PBE)	Learning grounded in local environments	Connects literacy activities with learners' lived experiences and geographic realities	Anchors reading within local environmental contexts	Contextual grounding
Culturally sustaining pedagogy (CSP)	Cultural identity and linguistic inclusion	Encourages the use of English as a medium for expressing local cultural knowledge	Provides cultural identity alignment within literacy learning	Sociocultural dimension
Cognitive theory of multimedia learning (CTML)	Cognitive processing in multimedia environments	Ensures that visual and auditory elements support comprehension and avoid cognitive overload	Guides multimedia instructional design in digital literacy environments	Cognitive mediation
Multimodality theory	Meaning-making through multiple semiotic modes	Explains how text, image, sound, and interaction collectively construct meaning	Enables multimodal representation of ecological narratives and information	Representational dimension

Table 1 suggests these theoretical traditions should not be seen as competing perspectives but complementary roles in generating and sustaining a coherent description of literacy. Reading literacy forms the cognitive foundation for the framework, which explains how learners decode meaning through texts as well as interpret and critically evaluate it. This dimension helps keep literacy instruction anchored in authentic comprehension practices. Eco-literacy adds an environmental perspective to the model by focusing reading materials on tools used for exploration of ecological systems, sustainability issues, and human-nature interactions.

Like Place-Based Education and Culturally Sustaining Pedagogy, the contextual dimension of this framework is about variety. These approaches assert that literacy learning is more meaningful when linked to learners' local environments, cultural identities and lived

experiences. Within EMRL, English serves as a conduit for learners to express ecological knowledge from their own communities. Finally, multimedia learning theory & multimodality theory explains how digital environments can effectively mediate ecological texts. Such theories inform the construction of multimodal learning materials — for instance, how images, audio and interactivity can be arranged to aid but not detract from understanding. This framework can operationalize the construction of EFL literacy through theoretical domains that combine cognitive processes, environmental content, contextual grounding and multimodal mediation into an integrated structure.

Based on the findings, this study discusses a theoretically coherent framework for environmentally contextualized literacy in global EFL education. Theoretical evidence reveal that reading literacy in cognitive knowledge, eco-literacy, context-to-setup sequencing and multimodal design can be aligned subsequently, provided in one unified framework: Eco-Marine Reading Literacy. The framework is built on four interconnected domains: a cognitive reading core; an ecological content domain; a contextual-cultural foundation; and a multimodal design mechanism. Collectively, they create a literacy ecology in which processes of comprehension interact with discursive sustainability, cultural grounding upon which the digital is mediated. The model is not a localized instructional strategy, but rather a transferable conceptual template applicable across environmental and cultural circumstances.

These findings contribute to existing scholarship in a number of key ways. Traditional reading literacy frameworks, including OECD-based definitions and cognitive models such as the Construction-Integration model, prioritize comprehension processes but resist claims to content specificity. The current framework preserves their cognitive rigor, and places them in the context of eco-centrism. In so doing, it addresses one of the many critiques that EFL literacy instruction privileges skills construction, separated from social contexts as also argued by Mcruer et al. (2025). Eco-literacy literature has long called for a robust perception of sustainability, yet the concept has traditionally been framed in science education contexts. EMRL strives to close this gap by implementing eco-literacy in language education via organizational reading schemes. This is in line with Rahmania (2024) showing this integration relates to interdisciplinary calls for sustainability across disciplines but goes further by articulating a specific literacy architecture.

Second, place-based education and culturally sustaining pedagogy argue the case for culturally meaningful instruction. Previous work as from Zhao et al. (2026), Winangsih & Kurniati (2020), and Misiaszek (2020) have shown that contextual relevance increases engagement and an exchange of personhood. These approaches rarely, however, but provide articulate structural underpinnings of how cognitive reading processes are embedded in contextualized texts. In this, EMRL synthesizes these traditions as conceptualizing cultural grounding a fundamental dimension rather than displacing demonstrable literacy outcomes. In this sense, the framework builds on work that has treated contextualization and topic enrichment in a more structural-than-thematic integration way.

Third, while multimedia learning research has primarily emphasized cognitive load management and dual-channel processing, multimodality theory focuses on semiotic meaning-making. Marco- and micro-level perspectives in previous digital EFL studies, however, have sometimes engaged with multimedia tools without establishing an explicit theoretical underpinning between cognition, content, and context. What sets the current

model apart is its explicit placement of multimedia design as a mediating agent in a larger literacy ecosystem (Bahanshal, 2023). This functional positioning prevents digital media from being reduced to mere technological enhancement and evokes an epistemic frame instead. The complementary nature of the selected theories may thus explain this study's conceptual convergence. Each speaks to a different dimension of literacy: cognition, content, context and mediation. Thus, what may seem like fragmentation in the scholarship could derive not from incompatibility but rather from disciplinary silos that have long separated environmental education from literacy theory, cultural pedagogy, and educational technology. As added by Rahman (2024), by reinterpreting these domains as structurally differentiated, yet mutually dependent, EMRL reveals their latent coherence.

At the same time, the framework departs from prior models in important ways. In contrast with purely cognitive literacy models, EMRL embraces a rejection of content neutrality. It does not privilege ideas about the environment over the measurable development of reading. In contrast with contextual pedagogies that prioritize identity politics as opposed by Galappaththi et al. (2025), it prioritizes academic rigor through formal methods of understanding. And unlike technology-centered frameworks, it avoids technological determinism by correlating multimedia design with pedagogical function.

However, being a conceptual study, the constructed framework is still on a theoretical level. Although it reflects strategic coherence and theoretical integration, empirical fixation is needed to evaluate its instructional effectiveness, learning engagement, and sustainability impacts in a variety of EFL contexts. Future research should employ this model in different ecological and cultural settings to establish its adherence and educational impact. In short, what the discussion highlighted is that Eco-Marine Reading Literacy does not entail a new thematic trend in EFL education. Instead, it presents a structural reconceptualization of literacy itself; one that embeds cognitive reading processes within ecological mindfulness, cultural place and multimodal mediation. This integrative architecture highlights how the study contributes a theoretically cohesive framework that can respond to contemporary educational and environmental challenges.

Conclusion

This study suggests Eco-Marine Reading Literacy (EMRL) as a conceptually integrated framework for eco-literacy informed by EFL education all over the world. The insights show that cognitive reading processes, ecological content orientation, contextual-cultural grounding and multimodal digital mediation can be productively aligned in a coherent conceptual architecture. Instead of analyzing these domains as distinct pedagogical trends, the framework frames them as interconnected aspects of literacy. In orchestrating this synthesis, EMRL redefines the ontological scope of global language education, shifting the pedagogical paradigm from passive linguistic consumption toward dynamic, eco-civic agency. By anchoring literacy acquisition within urgent socio-ecological realities, the model directly challenges the persistent fragmentation between environmental awareness and communicative competence. Ultimately, the study establishes that transforming EFL learners into critical ecological readers is not an auxiliary ambition, but an essential imperative for sustainable education in an increasingly interconnected and vulnerable world.

The implications are significant. First, in EFL literacy can no longer be understood as a content-free or context-free skill but needs to engage with ecological realities and sustainability discourse. Second, cognitively rigorous pedagogies can be integrated with contextual and/or culturally grounded pedagogies without losing their focus. Third, digital multimodal design must be underpinned by theory instead of being driven by technology. EMRL thus recontextualizes literacy as a fluid system in flux as conditions, environments, cultures, and technologies change. Functional integration is proposed as an answer to the theoretical gap previously identified, which is the dislocation between reading literacy, eco-literacy, contextual pedagogy and multimedia learning. The framework orients divergent, prior scholarship in a new way that links previously parallel and disjointed discussions. Nonetheless, this study is conceptual. It does not demonstrate an empirical substantiation of instructional effectiveness, learner outcomes, or sustainability impact. Further empirical investigation of EMRL is required to validate its effectiveness across a wider range of EFL contexts, adapt it to themes other than coastal or marine studies, and assess the long-term impact on students' ecological literacy and development of critical literacy. Through this framework, literacy is positioned in a globally minded sense of integrative global education as not only cognitively demanding but also socially responsive.

Declaration of the use of AI-assisted technologies

The author declares that no AI-assisted technologies were used at any stage in the preparation of this article.

Credit authorship contribution statement

Nyak Mutia Ismail: Writing – original draft, Supervision, Conceptualization Methodology, Investigation, Revision, Formal analysis.

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Declaration of competing interest

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics approval and consent to participate

Not applicable. This study is a conceptual and theoretical inquiry that synthesizes existing literature and curricular models; therefore, it did not involve human participants, individual patient/student data, or biological samples requiring formal institutional ethical clearance or informed consent.

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