

Enhancing Eco-Critical Language Awareness through Digital Scaffolding: Evidence from Monolingual and Bilingual ELT Classrooms

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Abstract

The ecological crisis is as language as it is as a meeting with the environment. Students who are learning English encounter ecological terminology in news articles, ads, policy information, social media and educational texts, and, increasingly, in AI-generated texts. This multiple-case study, which is qualitative in nature, investigates how scaffolding with digital resources can coexist with Eco-Critical Language Awareness (ECLA) in two different ecologies of English Language Teaching (ELT): An English-medium (EM) classroom and a bilingual/multilingual classroom in which translanguaging is a well-developed resource. The study combines concepts from ecolinguistics, Critical Language Awareness, scaffolding from a sociocultural perspective, Technology-Enhanced Language Learning and translanguaging to come up with a new theory: Eco-Critical Digital Scaffolding Theory (ECDST) and its classroom-based operational model: Digital Eco-Scaffolding Language Awareness Model (DESLAM). The analytical architecture is shifted from the noticing of lexical and grammatical aspects to the discursive and ideological interpretation, crosslingual comparison and eco-actional transfer. Classroom observation, semi-structured interviews, focus groups, digital annotations, reflective journals, learner-produced texts and stimulated recall are used to generate data. Reflexive thematic analysis involves theory-based concepts to sensitize the analysis and induction of meaning, with within-case analysis and cross-case synthesis. The main contribution of the manuscript is not the assertion that bilingualism or technology as such leads to critical awareness. Instead, it argues that digital visibility and multilingual repertoire can be complementary mediational resources as long as they are intentionally coordinated by teachers and peers. It is essential to include a methodological integrity note: This should include a description of the empirical procedures and what types of cases should be anticipated, but not include participant-level transcripts, coded data, frequencies, or verbatim quotations. This elegant form, therefore, does not create numerical results or quotations from the participants. The graphs that are in the paper are clearly labeled as being from the published literature, and the main study is shown as a detailed framework for analysis that can be reported in an empirical way.

Keywords: Eco-Critical Language Awareness, Ecolinguistics, Translanguaging, Critical Language Awareness, ECDST, DESLAM, ELT, Generative AI

1. Introduction

The 21st century is characterized by two major parallel developments: a crisis of ecology and a revolution in communication, supported by digital technologies. The ecological agenda is increasingly difficult to imagine as something that lies "beyond" education, due to the impacts of climate change, biodiversity loss, pollution, resource depletion and environmental injustice. At the same time, the importance of language has been revitalized as a communication medium that can help people to comprehend, communicate and respond to these crises. There are many sources of environmental reality other than personal experience, such as news media, textbooks, advertising, political rhetoric, social media, corporate communication, and, more recently, artificial intelligence (AI)-generated material. These words can thus affect the understanding of the interplay between human beings and nature, and they are used when talking about forest, animals, climate change, development or consumption.

ELT should not be just grammatical accuracy, vocabulary, pronunciation and communicative fluency in this context. English is the key language of international communication, scientific communication, the digital realm, and environmental communication; English learners are often subject to environmental problems in linguistic and multimodal texts. The need for developing learners' competence in language construction of ecological meanings, identities, relationships and ideologies is thus gaining more and more attention.

The study was born of three major occurrences: the ecological approach to language and applied linguistics, the digitalization of language teaching and the increasing linguistic diversity in the classrooms of today. These advances give a great foundation for the study of Eco-Critical Language Awareness as a compulsory part of studying modern English language. The study is based on the premise that language is never a neutral medium for the description of ecological reality. Lexical items, grammatical forms, metaphors, framing devices, narratives and multimodal representations can have a positive effect on certain aspects of the human-natural relationships, and a negative effect on others. Therefore, development of ecological awareness should be closely linked with development of critical awareness of language in language learners. The study begins by providing background information on the subject.

1.1 Background of the Study

This study belongs to the series of studies carried out in the wake of what can be called the "ecological turn" in linguistics and applied linguistics. Amongst the intellectual sources of this development, one of the most significant traces can be found in Halliday's highly influential talk, subsequently published as "New ways of meaning: The challenge to applied linguistics" (1990). Halliday was interested in the relationship between linguistic options and other aspects of social and material practice, and asked the following questions: Are there dominant linguistic patterns that can be associated with socially destructive thinking and behaviour around the environment? His intervention spurred linguists to think not only about the social world represented by language but also about how language systems and discourse contribute to constructing relationships between humans and the environment.

Halliday's work opened up an important niche for the development of the field of 'ecolinguistics', a study of the connections between language, human society and the ecological systems of which they are a part. Since then, research on "language ecology" has progressed far beyond the metaphorical discussion of "language ecology", and now includes critical studies of environmental discourse and the ideology implicit in language (Alexander and Stibbe, 2014; Stibbe, 2015; 2021). In particular (Alexander and Stibbe, 2014) call for a shift from just analysing texts on ecology to "ecological analysis of discourse" in general, that is, analysing texts of any topic for their assumptions about the human-nature relationship. The question that is currently pertinent for contemporary ecolinguistic studies is then: what stories do languages reproduce about human beings, nature, development and progress?

Stibbe's studies are significant in this regard because they consider language as a powerful cultural "story we live by" (Stibbe, 2015) which can be seen in framing, metaphor, evaluation, construction of identity, ideology and erasure. Ecolinguistic questions focus on the presence or absence of environmental language and on whether a particular type of discourse is ecologically damaging, ambivalent or positive. It has been shown in recent scholarship that ecolinguistics is a field of linguistic/educational studies that is constantly developing, and that much of this recent work has focused on ELT materials as a site of investigation. **Basya and Maulidia (2024)** use ECDA in examining secondary-level ELT textbooks in Indonesia, and conclude that textbooks serve as a vehicle for fostering the environmental consciousness of learners, which is an often overlooked role, and usually provided with anthropocentric and/or economically centered framing that is not ecologically responsible. This concern is related to the literature of eco-critical discourse studies that

have time and again demonstrated how environmental texts can be obfuscatory in such regards as agency concealment, individualizing responsibilities, and maintaining anthropocentric perspectives while appearing to be about environmental awareness (Xiong 2014; Zahoor and Janjua 2019). Only a small portion of what was surveyed discussed environmental issues, and the environmental education that was found was shallow in nature, focusing on physical signs of ecological damage but avoiding the cultural, political and ideological causes, which is what Stibbe (2004) found in Japanese EFL textbooks, and Xiong (2014) found in Chinese EFL textbooks. A similar study by Zahoor and Janjua (2019) on Pakistani English textbooks was conducted with a focus on the ecolinguistic and ecopedagogical evaluation of the textbooks, which showed that the value of "green" content in textbooks is not only the occurrence of the environmental content but also the linguistic and discursive representation of the human-nature relationship. This line of investigation goes back to the pioneering work of Jacobs and Goatly's (2000) audit of the coverage of ecological issues in ELT coursebooks, which first highlighted the mismatch between the aims of the coursebooks' authors and the linguistic execution of these topics. Steffensen and Fill (2014) place this stream of research in the larger context of the "state of the art" of the field of ecolinguistics, and describe it as a "new branch of applied linguistic and educational research".

Language in the environmental texts can be crucial since it can legitimate certain notions of responsibility, power, and the interrelationship between humans and nature. Natural resources, for instance, may be built virtually for its functional purpose. Likewise, passive sentences can make it difficult to determine responsibility for environmental harm: "Thousands of trees were destroyed" does not tell you who did it, but "The construction company destroyed thousands of trees" does. Applied linguistics, therefore, is given important implications by the ecological turn. Language education can play a role in teaching learners to recognize, question, and, as necessary, reshape problematic discourse patterns in which they encounter ecological issues if language is seen as a part of an ecology. This is not to say that ELT should take the place of environmental science, but rather that ELT is a means of learning how meanings are constructed, and how language is entangled in social and ideological processes.

The second big change that is influencing the current research is the digitalization of English language education. The learners' language resources have been vast amplified with the advent of Computer Assisted Language Learning (CALL), Technology-Enhanced Language Learning (TELL), online learning environments, digital corpora, multimodal resources, automated system of writing feedback, and various AI-based applications. This digital dimension is rooted in a much older and well-

established pedagogical theory of learning, that of the Zone of Proximal Development, described by Vygotsky, and of "scaffolding", described by Wood, Bruner and Ross (1976), as temporary, adjustable support provided to a learner to enable him or her to perform a task he or she cannot do independently. This scaffolding principle (Vygotsky, 1978; Wood, Bruner & Ross, 1976) can be interpreted as a technology extension via contemporary digital tools.

Recently, there have been more opportunities for language learning thanks to conversational and generative AI technologies. AI systems can provide interactive feedback, provide examples, facilitate multilingual interactions, help with writing, and reveal alternate interpretations of a text. Lai and Lee (2024) conducted a recent systematic review of conversational AI tools in ELT and found that research on this topic has surged since 2022, that studies have been carried out only in the Asian EFL context, and that so far, research has found that the use of these tools has led to measurable improvements in affective outcomes such as motivation and anxiety reduction, and in cognitive outcomes such as improving students' speaking capacity and vocabulary acquisition. While this body of research demonstrates the increasing importance of AI-mediated interaction for modern language instruction, it also reveals a limited geographic and contextual scope of the Asian EFL context that the current study, which to a certain extent is 'outside' the scope of the Asian EFL context, attempts to help fill.

Because of their ability to present learners with multiple iterations of environmental dialogue, digital and AI-supported environments are of great relevance for eco-critical learning. Learners can analyse various news articles, corporate sustainability reports, government policies, social media campaigns and AI-generated responses on the same ecological topic and compare metaphoric similarities and patterns and the approach by the actors to representing environmental issues and to taking responsibility for them. Digital tools can thus be used to scaffold critical noticing, rather than for grammar or vocabulary purposes. The possibilities of generative AI are not limited to monolingual, monomodal language learning but include multilingual and multimodal spaces for language learning. The study by Lin et al. (2025) illustrated the pedagogical potential of generative AI tools in the context of multimodal composition writing tasks in multicultural second-language classrooms, as well as the complicated nature of the scaffolding capabilities of these tools, which are explored in the present paper. New critical challenges, however, lie with the technologies that are generating this language: AI-generated language may reflect the dominant discourses, cultural assumptions and ideologies which inform the data used to train AI algorithms, and learners who use the AI-generated content

must also learn to critically examine whose voice is being amplified and which human-nature relationships are foregrounded or erased.

In addition to this technological strand, corpus-based methods will provide another methodological tool for eco-critical noticing. Poole (2016) shows how the application of corpus-aided ecolinguistic analysis can uncover how the “environment” is discursively produced in contemporary media texts, and that language corpora can be used as a methodologically precedent for the analysis of language as a site of critical eco-linguistic inquiry, which can be adapted to classroom settings.

Finally, the study is based on a third contemporary trend - the linguistically diverse classroom that is taught using English as the dominant language of instruction. Students are not necessarily monolingual; they may bring other linguistic and multilingual resources with them; such as regional languages, national languages, English and other linguistic form(s) which can shape the conceptualization and expression of the environment itself. In the seminal account of translanguaging, García and Li Wei (2014) make clear the importance of not thinking of linguistically diverse classrooms as an undifferentiated environment: bilingual learners' repertoires are not a problem to be solved but a cognitive and pedagogical resource. This premise has been increasingly used in the teaching of environmentally related instruction especially. In operationalizing the theory, Damico, Baildon and Panos (2020) demonstrate how an ecolinguistic and "stories-we-live-by" approach can be put into practice in the classroom to foster climate justice literacy in adolescent and adult learners. Zhou, Li and Gao (2021) also set up the discussion of translanguaging as a classroom ecology that is sustainable, in which the students' flexible use of their linguistic repertoire contributes to content learning and to a more equitable and adaptive learning environment. Of particular relevance to the concerns of the present study is Rosa et al.'s (2025) translanguaging pedagogical model, which is explicitly oriented toward a climate justice teaching unit in a multilingual classroom, and which illustrates how the cross-linguistic repertoires can be called upon to support the development of a critical lens for exploring ecological and social-justice concerns simultaneously.

Cross-linguistic comparison is therefore an especially crucial aspect of the eco-critical awareness. Not all concepts can be translated directly from one language into another: there may be culturally-specific terms for land, water, forests, agriculture, animals or human responsibility for the environment within one language that do not readily translate to another language, or there may be categories in the English environmental discourse that are not readily available in the learners' L1.

In these cases, ecological meaning making might therefore be a comparative process and learners might ask, such as: What is nature viewed as in English compared to the learners' language? Is there a difference between the different languages that encode a sense of ownership versus interdependence with nature? Which metaphors are translinguistic and which aren't? The bilingual and multilingual dimension is pedagogically significant as it can be used to make learning gains, as the language competence of the learner can be an advantage in learning rather than a disadvantage; a learner's ability to understand patterns of meaning across languages may enable him or her to see patterns of meaning that would not otherwise be apparent when working within a single language. There are only a few studies examining the interplay of bilingual repertoires and digital scaffolding and eco-critical consciousness together, however, and it is this gap that justifies the background and rationale for the present investigation.

In the last few years, English language teaching (ELT) has been growing in importance as a space for ecological, decolonial and technological issues to converge. In the field, the application of ecolinguistics has been gradually growing (Ha 2023). Micalay-Hurtado and Poole (2022) claim that critical language awareness (CLA) theories that ignore climate change are deficient and they present a CLT (eco-critical language awareness) framework featuring principles and activities for the classroom. The extent to which such concerns are realized in practice is reflected in textbook analyses. In Indonesian Senior High School EFL textbooks, an eco-beneficial discourse was found with a small number of ambivalent and destructive representations by Triyono et al. (2023). Liu et al. (2024) adopted the method of corpus and critical discourse analysis to analyse the twelve series of Chinese university textbooks to explore the main semantic fields of environment in these textbooks, some of which were analysed critically. However, in Brazil, Cristovão et al. (2022) found that textbooks utilize content from the external environment but do not necessarily provide for critical environmental literacy. This is confirmed by systematic reviews. Based on the review of 56 studies between 2018 and 2024, Dhanyamol and Sethunarayanan (2025) have found that Eco-ELT, environmental education and CLIL (content and language integrated instruction) are the dominant approaches. They also identified limited resources, poor alignment of sustainability goals with language goals, and poor teacher training as ongoing challenges, similar to the findings of Yu et al. (2024). Teacher oriented studies reveal the same limitations, such as a shortage of materials, time pressure, and the challenges of integrating language and environmental objectives (Mercer et al., 2023), as well as a lack of consensus among EFL teachers about how SD is perceived as a goal of education (Arslan and Curle, 2024). There are, however, pedagogical studies with a promising result. Ecocritical ELT has been

correlated with learners' connection to nature (Saiful and Shein, 2025), and Porto (2025) demonstrated that creative arts and community involvement positively enabled adolescents' growth as ecological citizens in Argentina. In the context of sustainable ELT, Meighan (2023) extends this agenda by suggesting an epistemic unlearning of colonial ideologies through the use of pedagogies of the heritage languages that can reconnect languages with place-based knowledge. Sometimes, parallel discussions about generative AI. Jeon et al. (2025) refer to three dilemmas in the use of AI in the classroom from a translanguaging perspective: the dilemma of creativity- standardisation, the dilemma of inclusion, fixity and the dilemma of meaning form. Jeon et al. (2024) warn of the potential of bias with speech-recognition chatbots in ELT. In the empirical study, Waluyo and Rouaghe (2025) discovered that Thai undergraduates started using translanguaging with AI translation tools, but the use of the tools did not significantly influence speaking learning. The overall picture of these studies indicates that ecological literacy, translanguaging and AI mediation are still largely separable and therefore, more studies are needed that will focus on the interaction of these components.

1.2 Statement of the Problem

Rationale for Eco-Critical Language Awareness (ECLA)

1.3 Research Questions

- RQ1. What is the role of structured digital scaffolding in supporting the learning of learners' development of Eco-Critical Language Awareness in the dominant monolingual ELT classroom?
- RQ2. How can the same scaffolding work in a bilingual/multilingual classroom where translanguaging is a recognized meaning-making tool?
- RQ3. How does the relationship between teacher, peers, digital and multilingual mediation work in an operational model of eco-critical ELT?

1.4 Scope and Positioning of the Study

The study is purposely qualitative and interpretive. It intent to describe the processes of noticing, negotiation and meaning reconstruction, and not to measure an effect size or state that bilingual learners are statistically superior over their monolingual counterparts. The comparison is thus ecological, not experimental, in that the two classrooms are considered as learning environments bounded by the linguistic resources, teacher practice, and digital affordances that influence the possibility for critical engagement. This same positioning also helps to avoid a typology error: that of

believing that bilingualism is an automatic advantage. This is an empirical proposition about the role of multilingual repertoires to be investigated based on the analysis of interaction and learner artefacts, not a predetermined result.

2. Literature Review & Theoretical Foundations

The proposed study takes an interdisciplinary approach to studying ecolinguistics, critical language awareness, sociocultural theories of learning, digital scaffolding, and bilingual/translanguaging pedagogy. Despite the different scholarly traditions, the idea that language learning is not just the learning of linguistic forms, but a socially, technologically and ideologically mediated process of constructing meaning and positioning self in relation to the world is common to the traditions.

The present review is then the conceptual groundwork of the proposed construct, Eco-Critical Digital Scaffolding Theory (ECDST). ECDST does not view ecological language awareness, critical discourse analysis and digital learning and bilingual pedagogy as separate units of instruction but rather as interacting mechanisms. In this framework learners are gradually made aware of the way in which language constructs the ecological reality, the different ways in which this occurs in different linguistic repertoires, the implications and ideologies of such constructions, and are finally supported to transfer this awareness into their own linguistic practices.

2.1 Ecolinguistics and the Ecology of Language

The intellectual heritage of ecolinguistics extends back to the interdisciplinary efforts to understand the interaction between language, society and the ecological systems in which human life is interwoven. Historically, the language ecology model has been used to describe the relationship between language and its sociocultural context, but new fields of ecolinguistics research focus on the influence of the linguistic structure of a text, the discourse patterns it exhibits, and the cultural stories it tells on human relationships to the more-than-human world.

This attitude stems in part from Halliday's (1990) compelling case against the neutrality of language. Halliday asked how the dominant linguistic patterns were connected to the economic and cultural systems that are linked to environmental degradation. His contribution was especially important because it turned from an analysis of language as a passive system of representation to an analysis of language as a tool through which certain worldviews are normalised.

From the Hallidayan point of view, the importance of grammatical choice lies on the relationship between grammar and categorisation of experience. How processes, participants and agency are represented can affect the meaning of responsibility. For instance, what is the difference between:

Industries polluted the river

and

The river was polluted

Is not only grammatical. The first construction clearly specifies an agent while the second construction highlights the affected environment and may background responsibility. Language differences have implications for environmental discourse because language-based choices can mask or reveal ecological action by human, institutional, or economic actors.

Ecolinguistic scholarship has since evolved this insight by analyzing ecological discourse, metaphor, framing, ideology and evaluation. Alexander and Stibbe (2014) differentiate between analysing ecological discourse and doing an ecological analysis of discourse. The latter is based on a qualitative assessment of the language patterns based on the type of ecological relationship that the patterns promote or hinder. The distinction is significant, as a text can be about the environment but not necessarily about environmentally beneficial ways of thinking.

The concept of 'stories we live by' by Stibbe offers an important theoretical framework for this present study. Stibbe (2015, 2021) suggests that societies are constructed by patterns that are repeated over time which have a cognitive-linguistic effect on how people perceive reality. These 'stories' can come out in the form of ideology, framing, metaphor, evaluation, identity, conviction and erasure. The intent of some stories could be to enable ecological destruction, while others may foster relationships of care, interdependence and sustainability.

The framework of nature-as-resource can create forests, water, land and animals mainly on the basis of their usefulness for human consumption. Likewise, prevalent stories of growth, development or progress can normalize the idea that there is no limit to economic growth, even as ecological boundaries are crossed. Conversely, different language structures can highlight stewardship, interconnectedness, reciprocity or the value of non-human life.

This theoretical approach has far-reaching implications for the ELL. In other words, if language is a vehicle for the reproduction of ecological worldviews then the language classroom is not ideologically neutral. Assumptions about the human-nature relationship can be communicated implicitly in vocabulary activities, reading passages, advertisements, and textbook or classroom narratives.

This concern is substantiated by research analyzing educational materials that reflects environmental discourse. This concern is supported by research on the discourse in the educational materials. Xiong

(2014) found that there was a form of 'shallow environmentalism', with mention of environmental issues but with little consideration of deeper structural, ideological and human causes, in secondary school English language materials through his eco-critical analysis. Zahoor (2020) also showed that the value of the English language textbooks in terms of the environment has to be analyzed not only in connection to the quantity of “green” content, but also in terms of the ecological orientation found in the discourse.

So the content dimension of the proposed framework is provided by ecolinguistics. It sets out what learners have to pay attention to: lexical patterns, grammatical structures, metaphors, frames and narratives in which the ecological relationships are represented. But it is not assumed that recognition and contestation of such patterns is enough to explain the development of learners' capacity to recognise and challenge the ecological discourse. This pedagogical dimension is based on the Critical Language Awareness.

2.2 Critical Language Awareness (CLA)

In general, Critical Language Awareness has grown out of the Critical Linguistics and Critical Discourse Analysis field, including the studies of researchers like Fairclough (1989, 1992, 1995). CLA questions the notion that language is an honest and unsentimental vehicle for the transmission of reality. Rather, language is seen as a social practice that is linked with ideology, power and the making of “common sense”.

Fairclough (1992) believes that language teaching must make learners aware of the relationship between language and social structure. The goal is not just to teach learners language skills, but also to help them not only understand how language can function effectively, but also how it can reinforce inequalities, institutional power and ideology.

2.3 Digital ELT, Generative AI and Scaffolding

The field of digital language learning has developed from CALL toward multimodal, collaborative and AI-supported language learning contexts. The need for conversational AI in the contemporary world is significant: according to a systematic review of the literature (Lai and Lee, 2024) published in 2024, there was a dramatic surge in the number of studies on conversational AI in ELT in 2022 and 2023 and the literature was overwhelmingly dominated by studies conducted in Asia in EFL settings. Mixed-method designs were common in the literature, while purely qualitative was a minority. The pattern reinforces the need for a qualitative research approach that is process oriented

which will enable them to understand the actual process in which the learners interpret and negotiate the ecological discourse through the use of AI as a simple tool rather than an intervention.

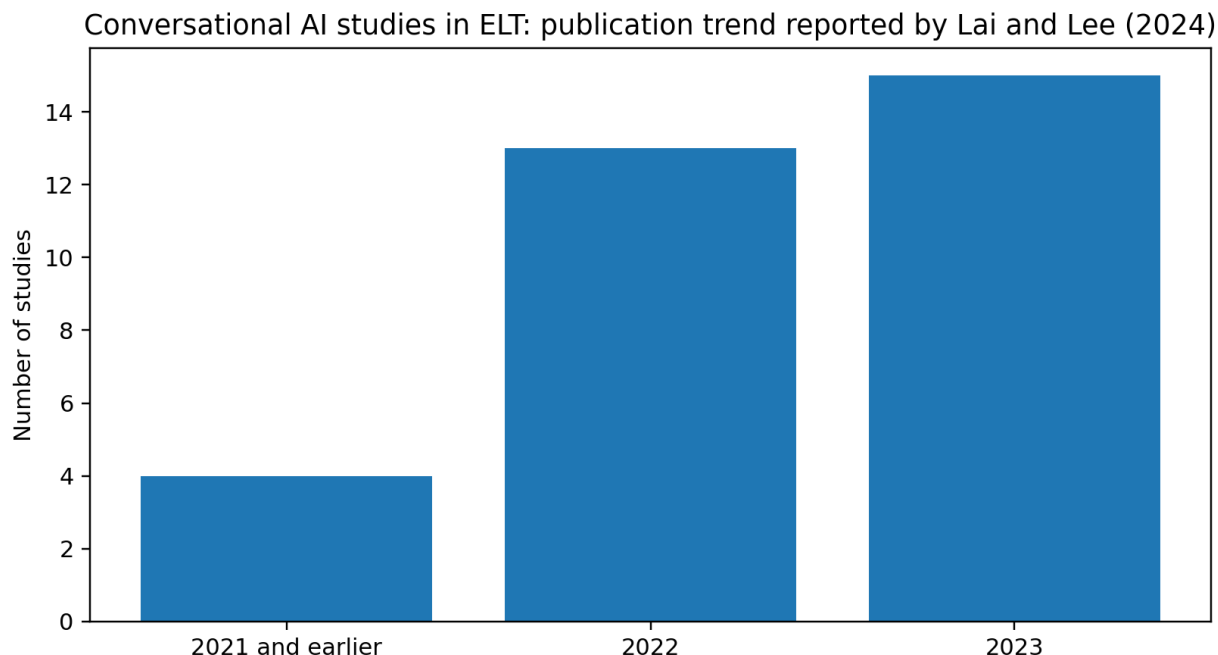


Figure 1. Contextual literature evidence: publication trend reported in Lai and Lee (2024). This is secondary evidence and is not primary data from the present classroom study.

Recent studies indicate that generative AI can be integrated into a pedagogical approach to provide support for multilingual assistance and feedback, revision, critical thinking and multimodal production, rather than serving as an autonomous answer engine. For instance, Lin et al. (2025) provide a description of L2 classroom usage of generative AI for writing, feedback/revision, multilingualism support, critical thinking, and visualization in a multicultural setting. Similarly, Li and Wilson (2025) suggest that with protecting student agency, scaffolding through AI can lower cognitive load and facilitate ideation and self-regulation. While this is directly relevant to this framework, the findings also underscore the importance of critical evaluation as part of the task design, since the output of AI can be a reiteration of dominant assumption rather than an impartial exposure of it.

2.4 Translanguaging and digital Multilingual pedagogy

The growing linguistic diversity of classrooms poses an interesting question about the nature of language that exists as fully separate systems within the learner. Another view comes from translanguaging theory, which is related to García and Li Wei (2014), who conceived of bilingual and multilingual meaning making as invoking a co-ordinated linguistic repertoire.

This approach to bilingual learners does not view them as “switching” between two discrete language systems. Instead, they find ways to creatively and strategically use the linguistic, cultural and semiotic resources they have in order to make meaning.

The principle has far-reaching implications for the field of eco-critical language awareness. Even within the field of the environment, the ideas are not necessarily expressed the same way in different languages. Certain words with natural, land, waste, growth or development, cleanliness, sustainability connotations may have other cultural connotations.

Cross-linguistic comparison may thus be a critical inquiry tool for a bilingual learner. For instance, students can compare the meaning and culture in an English phrase to the meaning and culture in a Punjabi phrase, Hindi or another language. They might find that it's not possible to translate directly, or that one linguistic repertoire emphasizes one kind of relationship while the other emphasizes another. The bilingual classroom can therefore be an advantageous structure in terms of eco-critical noticing. This is because with the presence of multiple linguistic repertoires, learners may begin to identify that language is not one-to-one and clearly represents ecological reality.

This principle can be seen as follows:

Environmental Concepts → Language A → Language B → Language A and B comparison of meaning and framing of meaning → recognition of ideological difference.

The process does not mean that one language is more ecological than another. Rather, it is the aim to show that linguistic representation is not fixed but can be different, and that there are other ways of structuring ecological relationships.

The translanguaging approach can thus be used as a cognitive tool for critical awareness. As learners cross linguistic boundaries, they can be made more aware of meanings which have been naturalised in a given language. This is very similar to the objectives of CLA and ecolinguistics.

This study builds on this argument by exploring whether bilingual repertoires, when used in conjunction with explicit digital scaffolding, can enhance learners' capacity to identify ecological frames and ideological assumptions.

Translanguaging in the digital context has been gaining importance as a field of study. The results of a visual search conducted in 2024 revealed 32 empirical studies on digital translanguaging in the classroom and in online environments, showing that multilingual meaning-making is currently happening on online platforms and digitally mediated learning environments. This is important for ECLA because the concepts of the ecology do not always have the same semantic, cultural or ideological implications in different languages. Cross-linguistic comparison can thus be used as an analytical tool, as learners investigate what is foregrounded, backgrounded, and/or altered when an ecological concept is reformulated otherwise within their language system (García and Li Wei, 2014).

2.5 Eco-Critical Digital Scaffolding Theory (ECDST)

ECDST is suggested as a blending theory, not as claims for the newness of the traditions that comprise it. Ecolinguistics is about why environmental discourse is worthy of linguistic analysis; Critical Language Awareness is about how the mediational resources of learners can be interrogated; the mediated development of competence is addressed through the lens of a sociocultural theory, and digital scaffolding is about mediation that can be introduced to a learner's environment. Why is environmental discourse worthy of linguistic inquiry is the topic of ecolinguistics; how can the mediational resources of the learner be interrogated is the topic of Critical Language Awareness; how is competence developed is mediated is the topic of a sociocultural theory and how can digital scaffolding be used to expand a learner's mediational resources is the topic of digital scaffolding. The novelty is in articulating the ways in which these resources can be coordinated around a developmental sequence of noticing to ecological language action.

Eco-Critical Language Awareness is the evolving ability to identify, analyse, compare and critically appraise linguistic, discursive and multimodal depictions of human–nature interactions, and to make more explicitly ecological communicative decisions. It understands the concept of critical awareness as a developmental one, not dichotomous. A learner might see the word “resource”, and then spot agency in an intransitive sentence, identify agency in the frame of nature-as-commodity, compare the frame between different languages, and finally, reconstruct the message. There are different supports that are required for each movement.

Refined Eco-Critical Digital Scaffolding Architecture

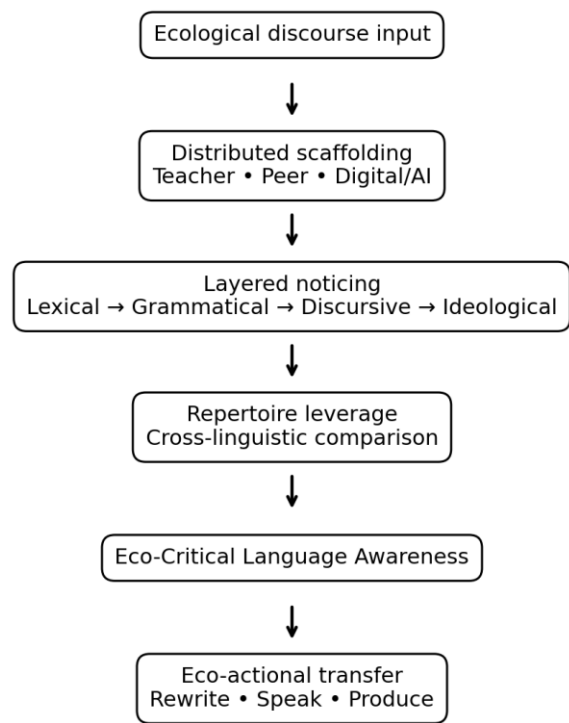


Figure 3. Refined ECDST architecture.

Table1. Four Interacting Principles

Principle	Core function	Indicative learner movement
Layered noticing	Moves attention from words and grammar to discourse, ideology and ecological values.	“What word?” → “Who acts?” → “What frame?” → “What worldview?”
Repertoire leverage	Uses L1/L2/multilingual resources for contrastive ecological meaning-making.	Expression → cross-linguistic comparison → alternative framing
Distributed scaffolding	Coordinates teacher, peer and digital mediation rather than assigning authority to technology alone.	Prompt → dialogue → comparison → increasingly independent analysis

Eco-actional transfer	Connects critical interpretation with learners' own communicative choices.	Recognition → critique → reconstruction → responsible production
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The model thus suggests a mediational logic of change: digital visibility can heighten the visibility of patterns; teacher and peer dialogue can provide a context for them; multi-language comparison can provide other framings; and scaffold fading can help enhance independent language choice. The framework is flexible and adaptable to the sociocultural focus on contingent assistance (Vygotsky, 1978; Wood, Bruner and Ross, 1976), and expands the goal of scaffolding from correctness in language to noticing in broader contexts of ecology and ideology.

3. Research Gap & Conceptual Proposition

It is important to note, however, that the study proposed in the manuscript does not suggest that there is no existing research that draws on the connection between ecolinguistics and Critical Language Awareness, since the last decade has seen the explicit development of an eco-CLA approach to ELT and pedagogical principles for integrating ecological and critical perspectives.

The more solid and defensible research gap is thus more specific.

Gap 1: Lack of focus on scaffolding theory in relation to the integration of eco-critical awareness.

Current eco-critical and ecolinguistic pedagogies describe what learners should be taught to critically examine, but fewer theoretic developments have focused on the process of scaffolding learners from initial noticing of language to autonomous ideological critical analysis.

ECDST proposes a principle called 'Layered Noticing' that seeks to remedy this.

Gap 2: Digital scaffolding research is largely skill based.

Most research on digital and AI-assisted scaffolding has been directed toward outcomes of writing ability, vocabulary, grammar, feedback uptake, speaking practice, learner autonomy and self-regulation. Conceptual fragmentation and limited attention to scaffold fading and transfer are identified in recent reviews.

Little research exists in relation to digital scaffolding for ideological noticing and eco-critical discourse analysis.

ECDST therefore broadens the scope of scaffolding from:

What are some of the ways technology can support learners in producing more accurate language?
to:

How is technology a means to make students aware of and question the ideology and ecology of language?

Gap 4: Insufficient use of a translanguaging approach to analyzing ecological discourse

In recent years the importance of translanguaging for criticality, multilingual identity and digitally mediated learning has been more extensively shown in translanguaging research.

The use of bilingual/multilingual repertoires as a systematic approach to comparing ecological frames, metaphors, agency patterns and human–nature relationship across languages, however, is not fully developed.

This is the suggested gap in Repertoire Leverage.

Gap 4: Divide between human and technological scaffolding

AI and digital systems are increasingly capable of providing prompts, feedback, examples and adaptive assistance. The need for pedagogical frameworks, however, remains, which would explain how support should be shared between teachers, peers and digital agents, especially when the learning goal incorporates complex ideological and ethical interpretation.

ECDST does this by the Distributed Scaffolding principle.

(Gap 5): Limited focus on transfer from eco-critical comprehension to language production

Digital Visibility + Linguistic Repertoire Leverage → Critical Ecological Noticing → Eco-Critical Interpretation → Eco-Actional Transfer is the consolidated proposition. This proposition is stated in a way that allows for qualitative evidence to be used to test it. The study does not claim that bilingual learners will always perform better than monolingual learners, and that the use of AI will always increase criticality. Rather, it questions the different resources that are mobilized, who mobilizes them, when in the learning process, and with what consequences in terms of interpretation and production.

4. Methodology

This study is based on an interpretivist/social-constructivist paradigm and qualitative multiple-case design. The two cases are bounded ELT classrooms (Case A is mostly monolingual, English-medium; Case B is mostly bilingual/multilingual, with an established translanguaging culture). Purposive

sampling is suitable as it is not about statistical representation but rather information rich and context driven understanding. The intervention is based on the following core activities: AI-supported glossing and paraphrasing, collaborative digital annotation, comparative work with a bilingual/multilingual corpus and reflective digital journals. These are employed as contingent scaffolds, and the teacher remains responsible for the contextualisation and critical discussion.

Data generated comprises classroom observations and field notes, teacher interviews, focus groups with learners, digitally added annotations, reflective journals, learner produced texts and ethically permissible stimulated recall sessions based on screen shots. Reflexive thematic analysis is a method that involves combining a set of deductive sensitisers from ECDST/DESLAM with a set of codes that are inductively generated from participant's accounts. Case analysis: Each case is analysed before cross case analysis. Trustworthiness is supported by triangulation across data sources, member checking (where appropriate), thick description, reflexive memoing and audit trail, with adherence to the principles of credibility, transferability, dependability and confirmability of Lincoln and Guba.

Methodological integrity statement. The provided manuscript includes only the qualitative design, instruments and expected analysis contrasts and does not include a list of participants, coded transcript set, code frequencies, quotation bank or artefacts. This fine manuscript does not therefore "invent" numbers or percentages, or run statistical tests or provide verbatim quotations. In the revised article, any statement that is marked using the words 'may', 'anticipated' or 'will' in the source text is treated as an analytical proposition to be considered as opposed to an invented empirical fact. The difference is crucial for any study in qualitative to be publishable.

Qualitative data-analysis pathway

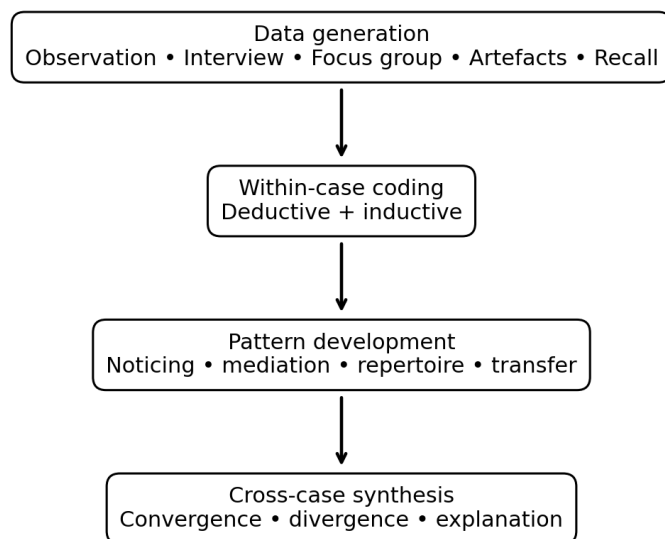


Figure 4. Qualitative data-analysis pathway for the study.

Table2. Data Analysis and Coding Framework

Analytical domain	Primary evidence	Interpretive question
Linguistic noticing	Annotations; learner texts; observation	What lexical or grammatical feature became visible?
Digital mediation	Screen captures; AI interactions; journals	How did the tool direct, constrain or extend noticing?
Critical/ecological noticing	Discussion; interview; artefact	What ecological frame, ideology or assumption was recognised?
Translanguaging	Bilingual dialogue; comparative notes	What changed when the concept was considered through another repertoire?
Teacher/peer mediation	Observation; focus groups	How did interaction deepen or redirect interpretation?

Eco-actional transfer	Rewritten texts; digital productions; reflections	Did critical noticing alter the learner's own communicative choices?
Scaffold fading	Later tasks; independent production	What support could be withdrawn without losing critical engagement?
Unexpected evidence	All sources	Where does participant meaning contradict or complicate ECDST?

5. Findings & Cross-Case Analytical Synthesis

Since the supplied manuscript does not include a final dataset of coded material, the results are expressed as a disciplined analytical synthesis of the case patterns already expressed in the source, not as quantitative empirical results. This is the format that ensures the qualitative nature of the study and does not lead to overclaiming.

5.1 Case A: Predominantly Monolingual Classroom

The monolingual case is described in the source manuscript as a context to critical noticing where digital tools and teacher cues are used as the main supports. Lexical and grammatical patterns become more visible through annotation and paraphrasing with the help of AI, however, the process of interpreting in the ideological dimension will need more teacher mediation. It is not that the monolingual environment is not critical potential but that cross-linguistic comparison is not as easily available as a spontaneous resource. The pedagogical pathway is thus produced in a more explicit fashion: learners are made aware of a feature, then asked to respond to prompts, then to discuss the meaning of that feature and revisit and gradually build up the discourse.

5.2 Case B: Bilingual/Multilingual Classroom

Bilingual/multilingual case presents more opportunities for translanguaging, contrastive noticing and collaborative negotiation. Source manuscript assumes that students will switch back and forth among languages, digital resources and peer discussion. Within this context, digital technologies are seen not as a replacement for other language tools, but as an aid to help learners to visualise, compare and extend their language tools. The analytical proposition is that multilingual repertoires may offer

alternative ways to the ecology of meaning, particularly when culturally embedded associations are hard to access via English alone.

Table3. Cross-Case Comparison

Dimension	Case A: Monolingual	Case B: Bilingual/Multilingual
Primary noticing resource	Digital and teacher prompts	Digital prompts plus cross-linguistic comparison
Learning movement	More explicitly sequential	More recursive and dialogic
Teacher role	Strong mediator of critical reflection	Facilitator of multilingual negotiation
Digital role	Visibility, annotation and alternative wording	Bridge between digital evidence and linguistic repertoires
Critical reflection	Requires deliberate prompting	Can be activated through contrastive noticing
Eco-actional transfer	Individual reconstruction	Multilingual/contextually negotiated reconstruction

5.4 Evidence-to-Model Mapping

The cross case synthesis leads to the development of the original linear DESLAM logic to a recursive ECDST process. Comparing in a cross-linguistic way should not be considered as a final step after noticing, but should be revisited throughout analysis. Likewise, digital mediation ought not to be limited to the start of a lesson. After peer discussion, the learner can go back to the AI-generated alternative, a corpus example or an annotation if they have changed their interpretation. The refined model then proposes that repertoire leverage and digital mediation can be used as resources that are cross-cutting and interact with layered noticing.

6. Discussion

6.1 Interpretation in Light of Eco-Critical Digital Scaffolding Theory

The results are explained by the proposed Eco-Critical Digital Scaffolding Theory (ECDST) with a main tenet of this theory that trilayer visibility (linguistic, technological, and ideological) supports

critical uptake. The discussion will focus on how to reveal linguistic patterns with digital tools, how to support a learner's interaction with technology, and the subsequent exposure of the ideological and ecological assumptions in discourse in order to gain deeper understanding of Eco-Critical Language Awareness. It will also review whether the results support the suggested progression from "noticing" to "critical interpretation" and "transferring" to "acting".

The study of the monolingual and bilingual scaffolding effects is discussed in a comparative way. Comparative discussion between monolingual and bilingual scaffolding effects.

This section answers RQ2 by contrasting the scaffolding used in the monolingual and bilingual/multilingual classrooms. The discussion will shed light on differences based on translanguaging theory and ecolinguistics, especially in cross-linguistic comparison as a critical noticing mechanism. It will examine the potential of bilingual learners' access to multiple linguistic repertoires as a means to a more earlier, deeper or more recursive examination of ecological meanings, and will highlight the part that the teacher and digital mediation may play in both contexts. Learner agency, critical reflection, translanguaging practices and transfer into language production will be compared.

6.2 Theoretical Contributions

The purpose of this section is to situate the study's theoretical contribution by claiming that ECDST and DESLAM did not represent new amalgamations of theories, but rather extensions of the theories that are already established. ECDST rediscovers scaffolding as an opportunity to notice ideologies, ecology, rather than just linguistic accuracy; and considers digital tools and multiple language repertoires as mediational resources. DESLAM offers the corresponding classroom operational architecture – the steps through which these theoretical steps turn into progressive stages of noticing, analysis, comparison, critique and language production. The empirical findings will be analysed to determine which elements of the models proposed are supported, modified or developed as a result of the study.

6.3 Pedagogical Implications

The results of this section are then explained in terms of practical recommendations for eco-critical digital ELT. It will suggest design principles for the creation of materials that incorporate environmental content and explicit consideration of lexical choice, framing, agency, metaphor and ideology. Teachers will be encouraged to use digital scaffolds contingently by providing more support when first noticing, and fades out over time as learners become more independent and critical.

Bilingual and multilingual classrooms allow teachers to intentionally build translanguaging and cross-linguistic comparison, specifically at the end of DESLAM, to facilitate the identification of alternative ecological framings and cross-linguistic meaning making. The overall pedagogical focus will be: noticing supported → critical interpretation → independent language choice → eco-actional communication.

The findings as synthesis are in keeping with the concept of EE becoming more consequential if learners investigate the stories and frames through which ecological realities are represented (Alexander and Stibbe, 2014; Stibbe, 2015; 2021). They further bring up the issue of shallow environmental concerns, which has been discussed in the ELT material studies (Xiong, 2014; Zahoor, 2020), when the learners are asked to detect environmental problems without going into the discourse that constructs them. ECLA consequently proposes a change in the conception of ecological competence, as partly a language-awareness competence.

The digital aspect introduces an additional complexity. While AI can provide learners with alternative formulations and make language patterns visible, it can also champion dominant narratives. The key isn't to have learners believe or disbelieve AI wholesale, but to encourage them to take an active part in their own learning. The critical task is to not allow students to automatically accept or reject AI, but to allow students to participate in their learning. It's to use AI-generated content as a benchmark. This is consistent with recent research that has demonstrated the potential for generative AI to help learners write in multiple languages and modalities, but not without the need for evaluations and pedagogical guidance (Lin et al., 2025; Li and Wilson, 2025).

The bilingual part also needs to be nuanced. In this respect, translanguaging is most useful not because it makes the learners more capable, but because it allows them to see linguistic contingency. If an ecological concept is presented in more than one repertoire learners might observe that the meanings of ownership, stewardship, cleanliness, development or interdependence are not static. This grounds repertoire as a metalinguistic enquiry. A review of the literature on digital translanguaging also for 2024 supports the relevance of this integrated view, since the multilingual practices are becoming more and more institutionalized in digitally mediated learning contexts.

6.4 Theoretical Contribution

ECDST offers a developmental perspective of noticing ecocritically. Its first contribution is to define the things that are scaffolded—grammar, vocabulary or task completion, but also the ecological meaning which is made visible and interrogated. Its second contribution is to identify multiple

mediators (teacher, peers and digital tools) rather than the technology as the only mediator. The third contribution is to see multilingual repertoires as an interpretive resource. The fourth is the idea of “eco-actional transfer”—the question of whether the learner's own communicative production changes due to critical interpretation.

6.5 Pedagogical Implications

Consider environmental advertisements, news reports, sustainability statements, policy texts and a generated alternative as objects of language analysis instead of just comprehension passages.

Integrate explicit questions related to agency, framing, metaphor, evaluation, omission and responsibility into ELT tasks.

Do not take AI for granted as the ultimate authority – use AI to compare and see. Ask students to give reasons why a formulated product created by AI is convincing, problematic or incomplete.

Provide systematic opportunities for bilingual and multilingual learners to make comparisons between ecological concepts across languages and to discuss differences in meaning or nuances of emphasis.

Fade scaffolds gradually.

The aim is not to be constantly dependent on teacher cues and technology, it's independent eco-critical communication.

Ensure privacy and learner agency by removing unnecessary personal data from AI systems and clearly indicating the use of AI in AI-generated content.

7. Conclusion and limitations and future research

The following are the main findings of this report:

The authors argue that Eco-Critical Language Awareness (ECLA) can be effectively elaborated in the context of teaching ecological discourse by integrating critical linguistic analysis, digital scaffolding and multilingual meaning making. The results suggest that digital tools have the potential to help make implicit linguistic and ecological patterns explicit, and that the role of the teacher and peers is important in helping learners to move from noticing to an ideological interpretation. The monolingual and bilingual/multilingual cases provide some evidence that both types of learners can benefit from structured scaffolding through digital tools; however, cross-linguistic noticing and translanguaging interpretation may be available for bilingual learners. The results also suggest that

the shift from understanding to the individual students' reconstruction and production of environmentally responsible discourse is necessary for effective development of ECLA.

7.1 Contribution to Knowledge

The study adds to the theory, methodology and practice. Theoretically, it offers an Eco-Critical Digital Scaffolding Theory (ECDST) that links with the concepts of ecolinguistics, Critical Language Awareness, scaffolding (AS), and digital mediation and translanguaging. It also puts in practice these principles by using the Digital Eco-Scaffolding Language Awareness Model (DESLAM). The multiple-case design also illustrates the methodological approach in order to create detailed evidence regarding the development of eco-critical awareness in the classroom by means of classroom observation, interviews, digital artefacts and stimulated recall. In practice, the research provides principles for the development of ELT materials and contexts for learning that focus on critical ecological literacy and not only language accuracy, with the use of digital technologies.

The research challenges that can be identified in the study include the following:

It must be noted that there are a number of caveats. Thirdly, the multiple case study design and the relatively small and purposively selected number of groups of participants restrict the ability to generalise the findings statistically; the findings are meant to give contextual and theoretical transferability. Second, I believe that as an interpreter of classroom interaction, I may have affected the data generation and analysis more than I realized, despite the use of reflexive practices and an audit trail. Third, the results of the digital scaffolding can be affected by the specific AI, annotation, corpus and reflective tools used for scaffolding. Results may vary depending on platform design, AI functionality, and user experience with the technology. Lastly, the study documents learners' progress in a finite time span of the intervention and thus may not be able to provide evidence of the long-term impact of ECLA or its lasting effects on actual ecological practice.

7.2 Recommendations for Practice

The results indicate that the implementation of eco-critical language education needs to be placed in the mainstream of ELT and not the environment as an extra unit. Teachers should choose texts that reflect the reality of the environment and make learners aware of the choices of words, the framing, agents, metaphor, evaluation, and ideology. Digital tools should be used as scaffolds when noticing and then faded out as a learner's independence increases. Furthermore, teachers should integrate the use of AI assistance tools with human interaction and collaboration with peers as ecological and ideological interpretation calls for context-appropriate and value-based judgment. Translanguaging

should be intentionally promoted as a tool to contrast and compare ecological concepts across languages in a bilingual and multilingual classroom. Utilizing opportunities for learners to rewrite, produce and share their eco-critical texts for awareness to carry over into communicative practices is the ultimate goal.

7.3 Future research is recommended in the following areas:

The most compelling answer to the question, therefore, is both methodological and theoretical: the processes learners use to 'notice, negotiate, and reconstruct meaning' are the ones that should be analyzed in the study of eco-critical ELT. Digital scaffolding can enhance visibility and multilingual repertoires can offer contrasting ways to interpretation, but these don't replace human dialogue. ECDST offers a coherent description of how these resources can be orchestrated and DESLAM takes the theory and turns it into a sequence for the classroom. The framework is open to revision if the participants evidence recursive, contradictory or unexpected learning pathways.

The major weakness of the present supplied manuscript is that it lacks any record of the empirical data at the participants' level. Anonymised participant descriptors, excerpts from transcripts or focus groups, coded artefacts, an explicit audit trail and a table that lists how themes are supported within the cases should therefore be included in a publishable empirical version. Once these materials are ready, the qualitative results can be elaborated but without modifying the conceptual structure. Further research is needed that takes a longitudinal approach in studying the framework; a cross-linguistic study in various language combinations; further research to determine if an eco-actional transfer process remains outside the classroom; and a cross-class study of various educational levels.

8. Researcher reflexivity and ethical safeguards

Reflexivity is not an add-on or an afterthought, but it is a central concern as the researcher is interpreting classroom discussion, digital interactions, and ecological discussion. Prior assumptions that the researcher may have on environmental responsibility, bilingualism, AI and ELT, and analytic decisions that the researcher makes should be distinguished from participant meanings and be documented in reflexive memos. Ethical procedures should consider informed consent, anonymity, minimisation of collected data, secure storage of screen captures and AI generated artefacts, and transparency regarding the role of AI-generated content. For minors, the consent of the parent(s)/guardian(s) and the assent of the learner is required. It is also important to determine if AI platforms store prompts or input text and to steer clear of inputting identifiable participant information into outside platforms.

9. Future research recommendations

The most valid conclusion, therefore, is not only theoretical, but also methodological: eco-critical ELT should be studied in the way in which learners recognize, negotiate, and reconstruct the meanings. Digital scaffolding can enhance the visibility and multilingual repertoire can provide contrasting pathways to interpretation, but in neither case does the former replace the human dialogue. ECDST offers a unified framework for the orchestration of these resources and DESLAM translates the theory into a classroom sequence. The framework is open for revision when evidence from the participants shows recursive, contradictory or unexpected learning experiences.

A key drawback of the provided manuscript is the lack of empirical records on the participants. A published empirical version should, therefore, include: anonymised participant descriptors; a table that clarifies how the themes were evidenced across cases; an explicit audit trail; transcripts and/or excerpts from focus groups; and coded artefacts. Once these materials are available, the conceptual architecture can be left unchanged and the qualitative findings can be reinforced. Future research should investigate the framework over time and through various language combinations and educational levels, and explore the possibility of the eco-actional transfer beyond the classroom.

Investigative reflexivity and ethical protections

Reflexivity is not an add-on to classroom talk, digital interactions and ecological discourse, as the researcher interprets it. The researcher should have preconceived ideas regarding environmental responsibility, bilingualism, AI and ELT; differentiate between the meanings that the participants have and the meanings that the researcher constructs; and document analytic decisions through reflexive memos. For informed consent, anonymity, data minimisation, the secure storage of screen captures and digital artefacts, and transparency of the use of AI-generated content, ethical procedures should be put in place. Parent/Guardian consent/learner assent is required for minors. The study should also indicate whether the prompts or text uploaded were saved on AI platforms and whether the participants' information was fed into external platforms.

10. Final Refined ECDST Model

An abstract model of the refined ecological discourse can be expressed as follows: input is ecological discourse, output are the teacher, peer and digital agents, input is layered noticing, output is lexical, grammatical, discursive and ideological patterns visible, input is repertoire leverage, output is cross-linguistic comparison, input is critical interpretation, output is ECLA, and input is eco-actional transfer, output is reconstruction and independent use of ecological language. New evidence or perspectives can change interpretation, allowing the learner to go back to former stages of the model.

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