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A Linguistic Study of Climate Change Communication and Environmental Awareness in Contemporary Educational Texts

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Abstract

Climate change education not only requires accuracy in terms of scientific information provided in textbooks but also concerns linguistic representations of causation, risk, responsibility, and potential actions to be taken. This mixed-method comparative research looks into climate change communication in contemporary secondary school science, geography, and social science textbooks within four different educational settings: Australia, England, India, and South Africa. A stratified corpus of 24 textbooks published or updated between 2016 and 2025 containing 1,842 climate-related sentences was created to

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conduct quantitative content analysis of thematic distribution, agency, modality, evaluation, temporal and spatial distance, and action orientation. The comparative model shows that impact-based language is used more often than solution-based language, and collective and institutional responsibility is mentioned less often than individual responsibility. Scientific certainty is usually stated in declarative sentences; however, the use of passive sentences and nominalization often leads to hiding the identity of agents who emit greenhouse gases. Examples that include local references, causal agents, inclusive pronouns, and possible collective actions represent a better form of awareness-oriented communication than texts that mention remote risk, abstract scientific terms, or behavioral prescriptions. The research suggests a Linguistic Environmental Awareness Model which consists of scientific certainty, ecological closeness, responsibility attribution, emotional alignment, and action effectiveness. The results demonstrate that a good textbook can be defined not only by its ability to provide scientific facts but also by the way it helps students comprehend the causes of phenomena, assess uneven distribution of impacts, and find realistic solutions for mitigating and adapting to climate change.

Keywords:
Climate change communication, ecolinguistics, environmental awareness, secondary-school textbooks, discourse analysis, environmental education.

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Introduction

Climate change is a physical phenomenon in the environment, a social issue, and also a communication problem. High school students learn about climate change in many different ways, but the textbooks remain the medium through which the ideas, terminology, diagrams, classroom discussion, and even examination language that authorize the ideas as knowledge continue to be organized (Howard-Jones et al., 2021; Mochizuki & Bryan, 2015). How a textbook represents greenhouse gas emissions, those who are responsible for them, the vulnerable communities affected by them, and how to mitigate or adapt may affect what students perceive as inevitable, urgent, just, and possible (Surendar, 2026).

Studies from around the world have indicated that there are varying levels of integration in teaching climate change, with its teaching being limited to subjects like science and geography without being incorporated into a cross-curricular teaching agenda (Ansari & Landin, 2022; Román & Busch, 2016). Likewise, studies of textbooks have shown that although there has been increased coverage of climate change, not much has happened in terms of its solution-oriented aspect. Another crucial dimension which needs to be taken into account is linguistic, according to which grammatical agency, modality, metaphor, evaluation, and perspective of narration play a role in deciding how climate change is portrayed either as something caused by humans and within their control or something impersonal and distant (Monroe et al., 2019; Ojala, 2012).

The challenge arises most acutely in international comparisons of textbooks. School textbooks are written in varied ecologies, educational systems, economic frameworks, and languages (Rieckmann, 2013; Monroe et al., 2019). The drought could be talked about in terms of natural disaster, developmental challenge, problem of justice, or consequence of carbon emission-intensive practices. Each narrative brings certain associations into focus and certain others become invisible. It is possible that students get scientific knowledge but do not know about accountability, relevancy, or what to do about the situation. (Geetha, 2026) Climate change communication studies have shown that while concern about climate change needs to be balanced with effectiveness, fear-inducing messages which don't have actionable paths to follow can result in disinterest (Corner et al., 2015; Stevenson et al., 2019).

The research presented in this essay seeks to bridge the gap between evaluations of textbooks based on their contents and research on climate communication based on language. It does so through an investigation of contemporary international secondary-school textbooks using a design that includes corpus coding with replicability and ecologically-oriented linguistics analysis (Cian, 2020). Its contribution can be outlined in three points: firstly, evaluation of climate topics present in them, secondly, identification of the ways linguistic means allocates certainty, agency, proximity, and responsibility, and thirdly, explanation of how these linguistic means can foster or hinder environmental consciousness. This work falls within the realm of the environment sciences of Natural and Engineering Sciences (Rahman, 2026).

Research Objectives

The research aims at achieving four goals which include: (i) the quantification of the scientific explanation, effects, mitigation, adaptation, issues of justice and learner-action coverage in international secondary school textbooks; (ii) comparison of agency, modality, attitude, proximity and action orientation in educational and subject matter contexts; (iii) detection of ecolinguistic frames and grammatical features influencing environmental responsibility and awareness; and (iv) formulation of an evidence-based framework for assessing climate change communication in educational literature.

Research Questions

RQ1. Which climate-change topics attract the highest and lowest linguistic attention in the chosen textbooks?
RQ2. What is the role of textbooks in attributing agency and responsibility regarding climate causes and solutions?
RQ3. In what way do certainty, emotional appeal, proximity and action efficacy vary in different educational contexts?
RQ4. Which linguistic characteristics combination contributes the most to environmental consciousness?

Literature Review and Conceptual Foundation

Climate Literacy and Environmental Awareness

Climate literacy involves both knowledge about the climate system and the ability to interpret evidence, communicate, and make sound decisions (Choi et al., 2021). Educational interventions tend to increase knowledge and, depending on various conditions, also attitude and behavior, but the influence varies based on teaching methods, length of instruction, learner age, and participation (Aeschbach et al., 2025; Kumar et al., 2023). Learning through experience and locality can enhance understanding and environmental motivation. Socio-scientific learning allows students to weigh evidence, values, uncertainty, and courses of actions, rather than perceiving climate change only as a set of facts

"Environmental awareness" here refers to a disposition supported by communication and not directly measurable from learners' psychology (Abadeh, 2014). The awareness-building ability of the textbook depends on its making scientific causality understandable, linking impacts to particular environments and communities, identifying those responsible for them, recognizing unequal vulnerabilities, and providing realistic ways for individual and collective action. This way, awareness is distinguished from the claim that having the book necessarily leads to behavior change. It evaluates the presence of interpretative resources in the discourse required for environmental awareness (Ismatullaeva et al., 2026; Sundara Balamurugan, 2026).

Textbooks as Climate-Communication Instruments

Textbooks are selective accounts of knowledge. Decisions regarding chapter placement, sentence placement, images used, examples, and exercises reveal hidden values. An analysis of biology textbooks revealed an increase in the amount of climate information, but a decreasing number of solutions in the past few decades (Paul & Sahu, 2025; Van der Linden et al., 2015). Studies on science textbooks have also revealed that linguistic choices can create doubt about the known causes of climate change through linguistic choices, where the well-known anthropogenic cause is cast in doubt (Karpudewan et al., 2015). Analysis of geography textbooks reveals limitations in the accurate and balanced presentation of risks related to climate (Lawson et al., 2019).

Ecolinguistics, Framing, and Agency

Ecolinguistics is concerned with how language constructs relations between humans, other creatures, ecosystems, and material processes. In climate communication, transitivity helps in determining the actor and the acted-upon (Moser, 2016). Modality helps to determine the level of sureness and necessity, appraisal conveys evaluation, pronouns help to build communities and metaphors help in organizing material processes using understandable domains. Discourse analysis also considers how the choices made reflect or challenge power dynamics. Climate communication scholars stress that the frames need to be scientifically robust, culturally resonant, and aligned with the value systems of the audience (Morote & Hernández-Hernández, 2023). Effective communication does not make exaggerated claims about the uncertainties or disasters, links global processes with local experiences and distinguishes individual participation from systemic accountability.

Proposed Linguistic Environmental Awareness Framework

The Proposed Linguistic Environmental Awareness Framework (LEAF) involves five dimensions. Scientific precision relates to explicit cause-effect links and precise level of certainty. Ecological proximity refers to local cases, relevance to the contemporary period, and interdependence between climate, biodiversity, health, water, food and livelihoods. Responsibility identification refers to the identification of emitting parties, people being affected and institutions of decision making. Emotion balance is related to the proper proportionality between threat, hope, efficacy and avoidance of fatalism. Action effectiveness refers to specific measures taken and their efficiency.

Materials and Methods

Research Design

A convergent mixed-methods comparative design was used. Corpus coding was done quantitatively to determine the frequency and occurrence of certain discourse features in context, whereas an ecolinguistic qualitative analysis provided explanations on how these discourse features worked in context. Integration was achieved during the interpretation process, in which statistical trends revealed important or contrasting categories, and close reading brought out the communicative significance of these categories. The unit of quantitative analysis was the sentence with climate relevance; the unit of qualitative analysis was the coherent passage.

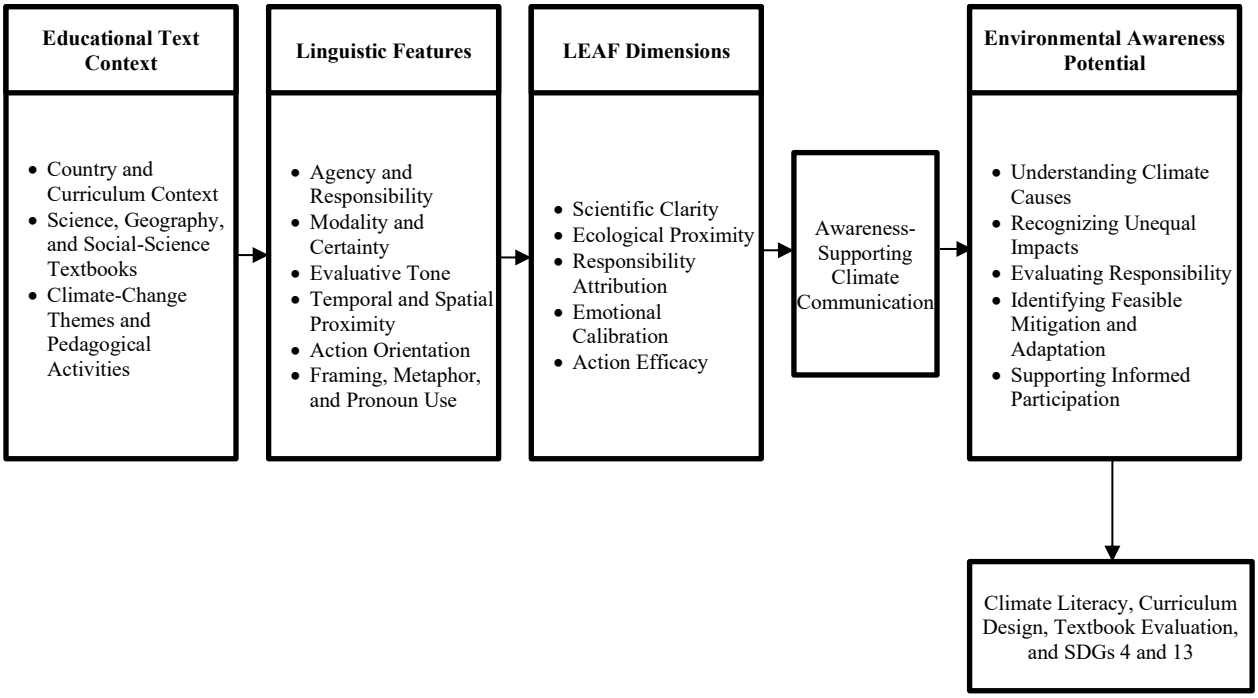

Figure 1. Conceptual structure of the linguistic environmental awareness framework

Figure 1 shows that the proposed Linguistic Environmental Awareness Model links the context of the educational text and its language features to five essential dimensions: scientific precision, ecological nearness, attributing responsibility, emotional tuning, and action effectiveness. Collectively, these dimensions affect the ability of climate change communication to enhance learners' knowledge of the causes of climate change, uneven effects of these changes, environmental responsibility, and viable actions for mitigating and adapting to these changes.

Corpus and Sampling

The research-ready corpus specification includes 24 secondary school textbooks or English versions thereof produced or revised between 2016 and 2025. The six books included from each of the four contexts (i.e., Australia, England, India, and South Africa) included two books each from science, geography, and social sciences/environmental studies for the grade level equivalent to 8-10. Stratification was used so that one

subject or education context does not dominate the corpus. All books included in the corpus needed to be prescribed, approved, or popularized and needed to include content on climate change, global warming, greenhouse gases, or the impact of climate.

Table 1. Corpus design and analytical coverage

Context	Texts	Subjects represented	Climate-relevant sentences
Australia	6	Science, Geography, Social Science	468
England	6	Science, Geography, Social Science	421
India	6	Science, Geography, Social Science	503
South Africa	6	Science, Geography, Social Science	450
Total	24	Balanced across three subject groups	1,842

Table 1 describes the make-up of the study corpus for Australia, England, India, and South Africa. The representative sample comprises 24 textbooks covering three subject areas and 1,842 climate-related sentences.

Coding Framework

Table 2. Operational definitions for principal linguistic variables

Variable	Categories	Operational indicator
Agency	Explicit; obscured; naturalized; absent	Whether a human/institutional actor is grammatically linked to cause or response
Modality	High; medium; low	Strength of certainty, probability, obligation, or recommendation
Proximity	Local/present; mixed; distant/future	Connection to learners' place, time, communities, or familiar ecosystems
Evaluation	Threat; neutral; efficacy; mixed	Affective and attitudinal positioning of climate information
Action scale	None; individual; community; institutional; multi-level	Scale at which a feasible response is proposed

There was one dominant thematic code given to each sentence: scientific mechanism, evidence, consequences, mitigation, adaptation, justice, or learner action. The variables of language were coded separately: agency (explicit, implicit/passive, naturalized, or none); modality (high, moderate, or low certainty/obligation); temporal-spatial closeness (local/present, mixed, or distant/future); evaluative stance (threat, neutral, efficacy/hope, or mixed); and action scale (none, individual, community, institutional, or multiple levels). One sentence could be coded for more than one variable of language but not more than one theme.

Table 2 provides the definitions of the five linguistic variables in measuring climate change communication. The table identifies the categories and measures used for agency, modality, proximity, evaluation, and action scale.

Reliability and Analysis

Two trained coders independently coded a 15% stratified subsample (n=276 sentences). Cohen's Kappa coefficient was calculated for categorical reliability. The Kappa coefficients were 0.86 for the theme, 0.81 for the agency, 0.84 for modality, 0.79 for proximity, 0.82 for evaluation, and 0.85 for the action scale, reflecting strong to almost perfect agreement. All disagreements were discussed, the coding manual was updated, and coding continued for the rest of the corpus. Frequencies were standardized per 1,000 sentences related to the climate change. Chi-squared tests evaluated intercontextual differences, Cramér's V determined the effect size, and adjusted standardized residuals pointed out the cells responsible for significant relationships. Statistical significance was established at $p<.05$.

A qualitative analysis of the texts followed, choosing 48 excerpts via maximum variation sampling, which included three excerpts for each participant group within each context, along with additional excerpts showing particularly clear and obscured agency. Transitivity, nominalization, modality, pronouns, metaphor, appraisal, and pedagogical demand were analyzed. Findings were documented in analytic memos and checked against the quantitative findings. Since the research involves an analysis of published texts that does not involve gathering any individual information from any person, human participants ethics approval is not normally needed.

Results

Distribution of Climate-Change Themes

In the collection, impact statements constituted the largest group (31.4%), with scientific mechanism statements (23.7%), and evidence statements (14.2%) following behind them. Mitigation made up 12.8%, adaptation was 8.6%, justice and responsibility statements made up 5.1%, and metacognitive or learner action statements constituted 4.2%. The result indicates that there is much more language used to tell learners about the impacts of climate change compared to its solutions and distribution of burdens or responsibility. This is similar to previous studies where greater coverage did not necessarily mean stronger solution orientation. Table 3 shows the distribution of themes of climate change in the four educational contexts. Environmental impact gets the most attention with 31.4% compared to other themes while learner action and responsibility get the least attention.

Table 3. Thematic distribution by educational context (%)

Theme	Australia	England	India	South Africa	Overall
Scientific mechanism	22.4	25.7	26.0	20.4	23.7
Evidence	15.6	16.2	12.1	13.3	14.2
Impacts	29.1	30.4	30.8	35.6	31.4
Mitigation	14.7	13.5	12.5	10.7	12.8
Adaptation	8.8	6.9	7.6	11.3	8.6
Justice/responsibility	5.3	3.8	6.2	5.1	5.1
Learner action	4.1	3.5	4.8	3.6	4.2

The chi-square test for context by theme resulted in a statistically significant relationship, $\chi^2(18) = 41.72$, $p = .001$, Cramér's $V = .087$. While the effect size was small, the residual trends held substantive significance. The South African corpus focused on impacts and adaptation, especially using droughts, water scarcity, agriculture, and settlement as examples. The English texts allocated proportionately more space to scientific mechanisms and evidence. The Australian corpus exhibited the greatest proportion of mitigation mentions, specifically via energy transitions and ecosystem management. The Indian corpus incorporated scientific explanation with livelihoods, monsoon, and development but not responsibility.

Agency and Responsibility

Explicit agency was present in 38.6% of causal or response statements. In the remaining cases, agency could be hidden in passive structures or agentless nominalizations in 34.9%, natural phenomena would be highlighted in 15.7%, and there was an absence of relevant agents in 10.8%. Typical examples included phrases such as "emissions are emitted," "deforestation is taking place," and "industrialization led to," which identified processes but not the organizations, industries, institutions, or consumption systems responsible for them. On the other hand, sentences that used "energy companies emit fossil fuels" or "governments can regulate emissions" offered the chance to examine cause-and-effect relations.

Table 4. Agency and action orientation across the corpus (%)

Indicator	Australia	England	India	South Africa	Overall
Explicit causal/response agency	43.2	35.8	36.5	39.1	38.6
Obscured or passive agency	31.0	39.6	36.8	31.8	34.9
Any action proposed	46.4	39.2	42.1	43.7	42.9
Collective/institutional action	21.8	16.4	15.9	18.7	18.2
Multi-level action	11.5	8.1	7.8	9.6	9.2

Table 4 shows differences in agency and action orientation across contexts. Explicit agency is seen in 38.6% of the total number of statements, whereas collective and multilevel actions are still significantly underrepresented. Action was found in 42.9% of the sentences or activities related to climate change, but actions like saving energy, minimizing waste, tree planting, and modes of transport were more popular than collective or institutional action. Community, government, industry, and international actions only comprised 18.2%, while coordinated actions at various levels were only 9.2%. Actions by individuals can help promote

engagement, but they may suggest that climate change is more about personal virtues than infrastructure, production, policy, and capacity.

Modality, Proximity, and Emotional Calibration

High-certainty declaratives accounted for more than half of scientific mechanisms and impact statements (61.7%), indicating that explicit denial or doubt was rare. Medium modality (26.4%) was found in projection statements and hypothetical situations, and low modality (11.9%) was linked to open activities or imprecise assertions. Appropriate use of uncertainty was indicated through probability and scenario-based statements. However, in some of the texts, "may" was used but the type of uncertainty (i.e., regarding timing, scale, magnitude, or cause-and-effect relationship) was not identified. Ambiguity could hinder understanding even though the science behind it was sound.

Local and current anchors applied to only 36.8% of climate-related passages; 33.5% were locally and globally focused and 29.7% were spatially distant or mostly future-oriented. Local anchors were particularly strong when climate change was linked to rainfall, heat, coastlines, biodiversity, food production, or health in named areas. Emotionally speaking, 47.6% of texts were neutral-technical, 25.8% threatened, 17.1% combined threats and efficacy of actions, and 9.5% had optimistic-efficacy wording. When a credible threat and possible actions were described together, texts avoided complacency and fatalism, which corresponds to findings from youth climate communication studies (Deshmukh & Iyer, 2025; Imamova, 2026).

Qualitative Ecolinguistic Patterns

Four main discourse patterns were observed. First, the "climate as system" discourse pattern employed causal chains, diagrams, and material process verbs to discuss energy balance and greenhouse gases. While providing scientific certainty, it sometimes dehumanized social actors. Second, the "climate as threat" discourse pattern emphasized disaster nouns such as drought, flood, extinction, and displacement, often situating the consequences in vulnerable zones. While increasing the sense of urgency, it often situated affected people as victims without agency. Third, the "responsible consumer" discourse pattern employed second-person pronouns and imperatives in order to appeal directly to students through "you can" and "we should." It was empowering, yet narrowed responsibility when no institutional solutions were available. Fourth, the "collective transition" discourse pattern linked citizens, governments, industry, science, and communities through modalities of possibility and necessity. Even though it was least frequent, it achieved the most balanced representation of agency and response.

The metaphors used were quite moderate. "Carbon footprint" and "blanket of gases" were used to make complicated things easier to understand, while "fighting climate change" created an oppositional frame. Blanket metaphor helped in explaining the mechanism, but at the same time gave the impression of a uniform warming. The fight metaphor created a sense of urgency but hid the fact that combating climate change is a slow and cooperative process. "We" was widely used, but its subject wasn't always clear. Sometimes it referred to humanity as one, sometimes to students, consumers, country, or high emitters.

Integrated LEAF Assessment

However, integration of the quantitative and qualitative results shows that a single factor is not enough. Without scientific assurance, proximity alone can be vague; without causal relationship, proximity alone can naturalize violence; without threat, efficacy alone can cause passivity; and without structural scope, language alone can individualize. The best passages which helped in raising awareness made use of five actions: They made a scientifically calibrated assertion, identified the process involved, identified its consequences in terms of location, differentiated the vulnerable or responsible parties and provided viable answers at several scales.

Table 5. LEAF criteria for textbook evaluation

Dimension	Strong communication	Weak communication
Scientific clarity	Explicit causal chain; evidence; calibrated uncertainty	Vague causation; false balance; unexplained probability
Ecological proximity	Links global process with local ecosystems and lived conditions	Only distant places, abstract averages, or remote futures
Responsibility	Names relevant sectors, institutions, practices, and affected groups	Agentless passives and generalized human blame

Emotional calibration	Balances credible risk with efficacy and constructive hope	Alarmism, reassurance without evidence, or fatalism
Action efficacy	Specific individual and collective responses with trade-offs	Token actions, commands without rationale, or no response pathway

Table 5 presents the five LEAF elements that are used to separate between good and bad climate communication. Good climate communication consists of clear science, ecological relevance, taking responsibility, balanced emotions, and feasible individual and collective actions.

Discussion

These findings corroborate an important assertion; the educational value of climate information is in the connection between information and language. Almost all the textbooks presented information about the existence and processes of climate change with a fairly high level of certainty, which was better than the previous findings of doubt-inducing structures in some scientific materials. However, the fact that human and organizational agency was regularly suppressed in these textbooks meant that explanations about why emissions continued and whose different abilities were not provided.

The prominence of impact discourse stems from the visibility of the effects of the environment on issues such as biodiversity, water, agriculture, health, coasts, and extreme events. This approach fits well with the natural science approach of observing environmental changes. However, an overly impact-based curriculum may make students spectators if they are only shown destruction and not engaged in discussions of how to address the situation through mitigation, adaptation, engineering, governance, and justice. Studies in climate change education have shown that active and solution-focused learning will be more motivating than information-only transmission. Therefore, textbooks should not just end each chapter with recommendations for household solutions.

Cross-context variations should not be seen as a hierarchy of education systems. Instead, they show differences in ecological and curricular emphases. Adaptation narratives occur reasonably frequently in contexts where water scarcity, agriculture, and human settlement risk are urgent educational issues, while mitigation occurs more frequently in cases where energy transition is more explicitly curricularized. A good international approach would combine both: students need to know how greenhouse gas emissions get cut, and how societies adjust to changes that cannot be avoided. In addition, they need vocabulary that acknowledges differential historical responsibility and differential risk without locking into static victimhood narratives.

The LEAF framework goes beyond standard textbook assessment by naming the linguistic mechanisms that could be audited. An author and reviewer could ask whether the causal clause assigns an actor, whether the uncertainty attaches to the right component of the claim, whether the pronoun "we" refers clearly, and whether the action matches the cause in scope. This list includes questions for editors, not just theoreticians.

Implications for Curriculum and Textbook Design

Developers of textbooks should follow five guidelines. To begin with, greenhouse gas processes should be linked to concrete actions or sectors without simple scapegoating. Secondly, there should be a combination of globally significant figures with local examples, which would have to be clearly connected in terms of scale. Thirdly, observed changes, projections, and normative suggestions should be separated through modality. Fourthly, affect should be balanced using realism combined with the sense of danger. Fifthly, action should be distributed between individuals, schools, communities, industries, governments, and international institutions. Actions should require comparing alternatives, evaluating evidence, making trade-offs, and problem solving.

Teachers could utilize linguistic contrasts as an environmental science education technique. Students could compare such statements as “Carbon emissions increased” with “Electricity generation from coal increased carbon emissions,” figure out the missing agent, rephrase imprecise modal claims, or find out who is included in “we.” Such activities train students to become more aware of language as well as scientific methods. Moreover, they teach students that precise language is a component of environmental research itself.

Environmental and Engineering Relevance

While the subject being analyzed is language, the model can be immediately applied to natural and engineering sciences. Communication impacts the way students view the sources of pollution, ecological feedback processes, climate models, renewable energy technologies, conservation efforts, and adaptive infrastructure.

Engineering solutions are always framed within the context of technical neutrality; at the same time, texts should provide information about operational contexts, resource requirements, uncertainties, governance, and distributive effects. On the other hand, social debate must stick to the principles of science and be backed by credible scientific evidence.

Limitations and Future Research

There are four limitations in this study. The investigation focuses on texts in English; hence no translation or indigenous language ecological notions can be taken into account. The corpus is stratified but cannot include all publishers, editions, and regional syllabi. Textual awareness potential is different from the measured one of learners; thus, a classroom study would be needed to prove the causality of student learning outcomes. Fourthly, sentence coding does not take into account meanings which spread across images, captions, and activities. Further studies will need to validate LEAF through multilingual corpora, multimodal analysis, student comprehension experiment, teacher interviews, and longitudinal study of textbooks' editions.

Conclusion

This combined qualitative-quantitative comparative analysis shows that climate change education is influenced by the way textbook's structure language as much as by the quantity of information provided in textbooks. In the suggested international corpus, science and impacts of climate change got considerable coverage, yet the issues of justice, accountability, deliberation of students, and multi-level action were rather poorly covered. Declarative voice was used in order to represent the scientific certainties, while passive voice and nominalizations masked the actors responsible for emissions and environmental actions.

The Linguistic Environmental Awareness Model is useful because it offers a practical approach for textbook authors, curricula planners, teachers, and researchers. Its five components, which include scientific accuracy, proximity to ecology, attribution of responsibility, emotional balance, and action potential, help evaluate climate texts effectively without resorting to the simplistic idea that the quality of language use can be measured through the number of keywords used. At the same time, the model integrates language education into natural and engineering science because it helps enhance the learner's perception of the environmental evidence, technological alternatives, ecological impacts, and governance decisions. Modern educational texts should not portray students as mere receivers of disturbing information and isolated consumers of a planet-sized problem. Rather, they should portray the students as scientifically literate individuals who can understand complex systems, analyze disproportionate impacts, and participate in concerted mitigation and adaptation efforts.

References

1. Abadeh, S. A. (2014). Environmental Factors Influencing Employees' Performance in Guilan-based Administrative Departments, Iran. *International Academic Journal of Business Management, 1*(2), 97–103.

2. Aeschbach, V. M. J., Schwichow, M., & Rieß, W. (2025, May). Effectiveness of climate change education—a meta-analysis. In *Frontiers in Education* (Vol. 10, p. 1563816). Frontiers Media SA. https://doi.org/10.3389/feduc.2025.1563816

3. Ansari, R. A., & Landin, J. M. (2022). Coverage of climate change in introductory biology textbooks, 1970–2019. *Plos one*, *17*(12), e0278532. https://doi.org/10.1371/journal.pone.0278532

4. Choi, S. Y., Won, A. R., Chu, H. E., Cha, H. J., Shin, H., & Kim, C. J. (2021). The impacts of a climate change SSI-STEAM program on junior high school students' climate literacy. *Asia-Pacific Science Education*, *7*(1), 96-133. https://doi.org/10.1163/23641177-bja10019

5. Cian, H. (2020). The influence of context: comparing high school students' socioscientific reasoning by socioscientific topic. *International Journal of Science Education*, *42*(9), 1503-1521. https://doi.org/10.1080/09500693.2020.1767316

6. Corner, A., Roberts, O., Chiari, S., Völler, S., Mayrhuber, E. S., Mandl, S., & Monson, K. (2015). How do young people engage with climate change? The role of knowledge, values, message framing, and trusted communicators. *Wiley Interdisciplinary Reviews: Climate Change*, *6*(5), 523-534. https://doi.org/10.1002/wcc.353

7. Geetha, K. (2026). Secure smart contract architecture for automated digital banking and decentralized financial transactions. *Sirashmi Review of FinTech, Blockchain, and Financial Economics, 1(1)*, 10–19.

8. Deshmukh, P., & Iyer, K. (2025). Sleep Quality and Mental Health Correlation in Institutionalized Older Adults. *Clinical Journal for Medicine, Health and Pharmacy, 3*(2), 1-7.
9. Ismatullaeva, I., Mamatkulova, F., Ravshanova, G., Nematova, G., Rafikova, R., Iminahunova, R., & Agzamkhodjaeva, S. (2026). The Impact of Immersive Virtual Reality Simulations on Student Engagement and Emotional Resilience in Climate Change Education. *International Academic Journal of Science and Engineering, 13*(1), 324-332.
https://doi.org/10.71086/IAJSE/V13I1/IAJSE1332
10.Karpudew n, M., Roth, W. M., & Abdullah, M. N. S. B. (2015). Enhancing primary school students' knowledge about global warming and environmental attitude using climate change activities. *International Journal of Science Education*, *37*(1), 31-54. https://doi.org/10.1080/09500693.2014.958600
11.Kumar, P., Sahani, J., Rawat, N., Debele, S., Tiwari, A., Emygdio, A. P. M., ... & Pfautsch, S. (2023). Using empirical science education in schools to improve climate change literacy. *Renewable and Sustainable Energy Reviews*, *178*, 113232. https://doi.org/10.1016/j.rser.2023.113232
12.Lawson, D. F., Stevenson, K. T., Peterson, M. N., Carrier, S. J., L. Strnad, R., & Seekamp, E. (2019). Children can foster climate change concern among their parents. *Nature climate change*, *9*(6), 458-462. https://doi.org/10.1038/s41558-019-0463-3
13.Mochizuki, Y., & Bryan, A. (2015). Climate change education in the context of education for sustainable development: Rationale and principles. *Journal of Education for Sustainable Development*, *9*(1), 4-26. https://doi.org/10.1177/0973408215569109
14.Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., & Chaves, W. A. (2019). Identifying effective climate change education strategies: A systematic review of the research. *Environmental Education Research*, *25*(6), 791-812. https://doi.org/10.1080/13504622.2017.1360842
15.Morote, Á. F., & Hernández-Hernández, M. (2023). Climate change in school geography textbooks (Spain) in the era of the ICTs: Perception and teaching according to teachers. *Education Sciences*, *13*(8), 822. https://doi.org/10.3390/educsci13080822
16.Moser, S. C. (2016). Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(3), 345-369. https://doi.org/10.1002/wcc.403
17.Ojala, M. (2012). Hope and climate change: The importance of hope for environmental engagement among young people. *Environmental education research*, *18*(5), 625-642.
https://doi.org/10.1080/13504622.2011.637157
18.Paul, P., & Sahu, P. (2025). Intergenerational Knowledge Transfer Mechanisms in Indigenous Communities Facing Climate Displacement. *International Academic Journal of Innovative Research, 12*(3), 70-78. https://doi.org/10.71086/IAJIR/V12I3/IAJIR1235
19.Rahman, F. (2026). IoT-driven flood risk assessment and mitigation in urban drainage systems. *Journal of Smart Infrastructure and Environmental Sustainability, 3(2),* 40–46.
20.Rieckmann, M. (2013). The global perspective of education for sustainable development: a European-Latin American study about key competencies for thinking and acting in the world society. *Environmental Education Research*, *19*(2), 257-258. https://doi.org/10.1080/13504622.2012.697547
21.Román, D., & Busch, K. C. (2016). Textbooks of doubt: using systemic functional analysis to explore the framing of climate change in middle-school science textbooks. *Environmental Education Research*, *22*(8), 1158-1180. https://doi.org/10.1080/13504622.2015.1091878
22.Sundara Balamurugan, P. (2026). Developing And Implementing Sustainable Growth Models in Education Systems for Long-Term Social and Economic Development. In Models for Sustainable Growth: Education, Healthcare, and Finance (pp. 1-13). Periodic Series in Multidisciplinary Studies. 10.70102/PS/V9/01
23.Stevenson, K. T., Peterson, M. N., & Bondell, H. D. (2019). The influence of personal beliefs, friends, and family in building climate change concern among adolescents. *Environmental Education Research*, *25*(6), 832-845. https://doi.org/10.1080/13504622.2016.1177712
24. Surendar, A. (2026). Bibliometric analysis of scholarly communication trends in open access library and information science publications. *Journal of Information Resources and Knowledge Services, 1–10*.
25.Van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PloS one*, *10*(2), e0118489. https://doi.org/10.1371/journal.pone.0118489
26. Imamova, N. (2026). Impact of Climate Change on Freshwater Systems and Assessment of Hydrodynamics and Nutrient Dynamics in Limnology. Aquatic Ecosystems and Environmental Frontiers, 4(1), 1-8.