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Green Technology and Sustainable English Language Pedagogy in Saudi Arabia: Trends, Challenges, and Future Directions

Mohammad Torikul Islam

Lecturer in English, Department of Foreign Languages, College of Arts and Humanities, Jazan University, Saudi Arabia
Email: mtorikul@jazanu.edu.sa / torikul99@gmail.com
ORCID ID: https://orcid.org/0000-0001-7188-5297

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Abstract— The global imperative for sustainable development has increasingly influenced educational discourse and prompted scholars and practitioners to examine how green technology (GT) can be harnessed to transform pedagogical practices. Higher educational institutions worldwide are being urged to align instructional innovation with environmental responsibility and long-term ecological sustainability. This systematic review investigates the integration of GT within English language teaching (ELT) in Saudi Arabia, with particular attention to prevailing conceptual frameworks, documented practical applications, persistent challenges, and emerging future directions. A systematic literature review (SLR) literature search has been conducted across five academic databases. It adheres to the guidelines of preferred reporting items for systematic reviews and meta-analyses (PRISMA, 2020). This SLR reveals that GT integration in ELT offers dual pedagogical advantage: it simultaneously enhances learners' English language proficiency and cultivates ecological literacy. Practical applications include digital platforms, project-based learning with technology, augmented reality, and AI-driven personalisation have been found to enrich ELT whilst reducing its environmental footprint. The findings contribute to the emerging discourse on English language pedagogy for sustainable development and offer actionable recommendations for researchers, educators, and policymakers in sustainable language education.

Keywords— Green technology, English language teaching, Saudi Vision 203, ecological literacy, systematic literature review

I. INTRODUCTION

The accelerating pace of environmental degradation and the growing urgency for the global sustainability agenda have compelled virtually every sector of society to reimagine its practices and responsibilities. Education, which is a cornerstone of societal transformation, occupies a uniquely strategic position in this paradigm shift. Scholars in the field of education for sustainable development have long argued that educational institutions bear a collective obligation not merely to transmit knowledge about environmental challenges but to actively model and promote ecologically responsible practices (Hockly, 2019). It is within this broader context that green technology (GT) has emerged as a particularly compelling instrument of paradigm shift.

GT may be broadly defined as the application of environmentally conscious tools, systems, and methodologies designed to reduce the adverse ecological footprint of human activity whilst simultaneously advancing sustainable development goals (Geronimo & Geronimo, 2019). The concept encompasses a wide spectrum of innovations—from renewable energy systems and energy-efficient infrastructure to digital learning tools and cloud-based educational platforms—each oriented towards minimising resource consumption, reducing waste,

and fostering ecological responsibility (Jamaluddin et al., 2018). Usares and Gonzales (2022) observe that educational institutions worldwide are increasingly recognising GT not merely as an operational upgrade but as a pedagogical philosophy that can reshape the very purpose and beliefs of learning.

Within the field of English language teaching (ELT), the integration of GT presents a particularly instructive dual advantage. Digital tools and eco-friendly pedagogical platforms have the capacity to modernise instructional methods, enhance learner engagement, and extend the accessibility of language education beyond the confines of the traditional classroom (Pegrum, 2014). On the other hand, when GT is embedded into the curriculum through principled frameworks, it enables ELT practitioners to position language learning as a vehicle for cultivating environmental consciousness and ecological literacy (Hockly, 2019). This convergence of linguistic and sustainability objectives reflects a broader shift in language education philosophy; one that views English not merely as a global communicative tool but as a medium through which learners can engage critically with pressing global challenges.

Saudi Arabia presents a particularly salient and timely context for examining GT integration in ELT. As one of the world's most robust economies, the Kingdom has embarked upon an ambitious programme of social and economic reform encapsulated in the Vision 2030 framework (Saudi Vision 2030, 2016). Central to this initiative is a commitment to diversifying the national economy, enhancing the quality of education, and embedding sustainable development principles across all sectors. Within the educational domain, this has manifested in substantial investments in digital infrastructure, the expansion of e-learning platforms, and the promotion of innovative pedagogical practices aligned with national sustainability objectives (Alalwan et al., 2019). Saudi Arabia's specific environmental challenges—including desertification, acute water scarcity, and significant carbon footprint—further underline the relevance of integrating GT into educational curricula that can cultivate environmentally aware and linguistically competent graduates.

Given this complex landscape, a systematic and comprehensive synthesis of the existing literature is both timely and necessary. This article presents an SLR of studies examining the integration of GT in ELT, with a particular focus on the Saudi Arabian context. It is guided by three overarching research questions: (1) What conceptual frameworks have been developed to integrate GT into ELT in Saudi Arabia? (2) What practical applications and innovations have been documented in the literature? (3) What challenges and barriers to GT integration persist? There is also a focus on future directions alongside these three research questions. This SLR addresses these questions and aims to consolidate existing knowledge, identify critical gaps, and inform evidence-based policy and practice in sustainable language education.

II. LITERATURE REVIEW

2.1 Conceptualising Green Technology

Green technology (GT)—also referred to in the scholarly literature as environmentally sustainable technology or clean technology—encompasses a broad range of tools, systems, and methodologies designed to reduce the negative environmental impact of human activity whilst promoting long-term ecological sustainability (Geronimo & Geronimo, 2019). At its philosophical core, GT is grounded in the principles of the 3Rs—reduce, reuse, and recycle—which guide the efficient utilisation of resources and the minimisation of waste across all sectors of human activity (Usares & Gonzales, 2022). These principles have been progressively extended beyond their original industrial applications to inform the operational and curricular practices of educational institutions worldwide.

A key exemplar of GT in the built educational environment is the concept of zero energy buildings, which are designed to achieve carbon neutrality by generating as much energy as they consume through renewable sources (Geronimo & Geronimo, 2019). Beyond infrastructure, GT encompasses the digital tools and platforms that reduce reliance on material resources such as paper, physical textbooks, and energy-intensive physical spaces. These tools and platforms align educational practices with global sustainability targets. Jamaluddin et al. (2018) argue persuasively that GT not only enhances operational efficiency within educational institutions but also fosters a culture of ecological responsibility that permeates the attitudes and behaviours of both educators and learners. This cultural dimension is particularly significant for ELT, where the values embedded in curricula have the potential to shape learners' worldviews well beyond the acquisition of linguistic competence (Hockly, 2019).

2.2 Green Technology in Education

The application of GT in formal educational settings has gained considerable momentum over the past decade, which is driven by mounting pressure from international sustainability frameworks, institutional commitments to reducing carbon footprints, and the rapid democratisation of digital technologies (Jamaluddin et al., 2018). Universities and schools globally are adopting a range of eco-friendly

practices—from the installation of solar panels and energy-efficient lighting to the wholesale transition from physical to digital learning materials (Suryawanshi & Narkhede, 2015). Virtual classrooms, cloud-based learning management systems, and synchronous online collaboration platforms have collectively reduced the demand for traditional classroom spaces and the associated energy consumption and transport-related emissions (Alhumaid et al., 2020).

The pedagogical dimensions of GT in education extend beyond infrastructure to encompass curricular design, teaching methodologies, and assessment practices. As Lay et al. (2013) observe, however, large-scale implementation of GT in education continues to confront significant structural impediments, including prohibitive upfront costs, insufficient technical literacy among educators, and a paucity of contextually relevant professional development programmes.

2.3 Green Technology in English Language Pedagogy

The intersection of GT and ELT has generated a growing body of innovative conceptual frameworks and practical pedagogical tools that seek to leverage the transformative potential of both fields simultaneously. Digital platforms and online learning environments substantially reduce English language pedagogy's reliance on traditional resource-intensive materials, whilst cloud-based resources and e-assessment tools align language teaching with the broader sustainability goals advocated by UNESCO (2017) and respond directly to calls for a more ecologically responsible educational practice (Geronimo & Geronimo, 2019).

Two conceptual frameworks deserve particular scholarly attention. The green language teaching approach (GLTA), articulated by Nur et al. (2022), proposes a principled methodology for embedding ecological themes into English language curricula. Rather than treating environmental content as an add-on, GLTA integrates it organically into vocabulary instruction, reading comprehension, listening and speaking tasks, as well as writing projects, thereby fostering ecological literacy as an indispensable complement to linguistic proficiency. Complementing GLTA, the context-aware ubiquitous language learning (CAULL) framework (Wang et al., 2019) employs mobile applications, GPS-enabled sensing systems, and augmented reality overlays to create immersive learning environments in which language acquisition and ecological exploration occur simultaneously and synergistically. These frameworks collectively reflect the conviction that technology-enriched ELT is most powerfully realised when it is anchored in real-world purposes and socially meaningful content (Pegrum, 2014).

2.4 GT in ELT: Environmental Sustainability in Saudi Arabian Context

Saudi Arabia's specific environmental profile lends particular urgency and relevance to the integration of GT in ELT. Saudi Arabia faces environmental pressures, including desertification affecting significant proportions of the national territory, water scarcity exacerbated by near-total dependence on desalination, and an energy consumption profile historically dominated by fossil fuels (Saudi Vision 2030, 2016). These challenges are not merely ecological; they carry profound social and economic implications for the long-term viability and sustainability of the national development trajectory. It is within this context that Vision 2030's explicit commitment to environmental sustainability, renewable energy expansion, and educational reform takes on its full significance (Alalwan et al., 2019).

The integration of GT in Saudi ELT programmes offers a contextually responsive mechanism for addressing these challenges at the level of individual learner consciousness and institutional culture. Frameworks such as GLTA which enable teachers to design English lessons to engage directly with local environmental realities using authentic language for genuine communicative purposes (Wang et al., 2019). Project-based approaches further enrich this engagement: students might develop English-language social media campaigns on recycling, conduct environmental interviews in the community, or collaborate on digital reports examining local ecological data (Widodo, 2015).

2.5 GT in ELT: Initiatives and Innovations in Saudi Arabia

Saudi Arabia has taken substantive steps to embed GT within its educational infrastructure as an integral component of Vision 2030's modernisation agenda. The widespread adoption of digital learning management systems, e-textbooks, and online assessment platforms in Saudi schools and universities has demonstrably reduced the sector's dependence on paper-based resources and the associated environmental costs (Alalwan et al., 2019). Several institutions have complemented these digital transitions with investments in renewable energy infrastructure which include solar-powered classrooms and energy-efficient building systems to promote an institutional commitment to environmental responsibility in discourse as well as practice (Jamaluddin et al., 2018).

In the domain of language education specifically, Saudi institutions have piloted innovative approaches drawing on artificial intelligence (AI), augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT) to create dynamic, personalised, and ecologically themed learning environments (Wang et al., 2019). AI-driven adaptive learning platforms, for instance, provide personalised

language instruction pathways whilst simultaneously reducing the need for printed assessment materials, which is a dual efficiency that aligns with both pedagogical and sustainability objectives.

III. METHODOLOGY

3.1 Research Design

This study adopts a systematic literature review (SLR) as its primary research design. An SLR is a structured and transparent approach to identifying, evaluating, and synthesising relevant research evidence to provide a comprehensive and unbiased overview of a defined phenomenon (Snyder, 2019). Systematic reviews are widely recognised as the most rigorous and transparent form of literature synthesis available to researchers and provide a replicable, evidence-based approach to consolidate knowledge on a defined phenomenon (Gough et al., 2017). Unlike traditional narrative reviews, systematic reviews follow explicit procedural steps that enhance methodological rigour, minimise selection bias, and improve replicability (Booth et al., 2016). Traditional narrative reviews are susceptible to selection bias and subjective interpretation. By contrast systematic literature reviews follow a pre-specified protocol that governs all stages of the process, i.e., from database searching and screening through to data extraction and synthesis, which ensures that the resulting synthesis is comprehensive, reproducible, and minimally biased (Page et al., 2021).

This methodological choice is particularly appropriate for the present inquiry, which seeks to synthesise a diverse and rapidly expanding body of evidence concerning GT integration in ELT within the Saudi Arabian context, a phenomenon that has not previously been subject to SLR. The review has been conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Page et al., 2021), which represent the current international standard for transparent and rigorous systematic review reporting.

3.2 Search Strategy

The identification of relevant literature is achieved through a systematic and comprehensive search of five major academic databases: Scopus, Web of Science (WoS), Education Resources Information Centre (ERIC), Directory of Open Access Journals (DOAJ), and Google Scholar. These databases have been selected on the basis of their broad disciplinary coverage, their indexing of high-quality peer-reviewed publications, and their established relevance to the intersecting fields of applied linguistics, educational technology, and sustainability studies. The primary search was conducted in December 2025, with a supplementary hand-search of the reference lists of all retrieved articles to identify additional relevant sources not captured through database searching alone.

The search employed a combination of controlled vocabulary terms and free-text keywords, connected through Boolean operators to maximise both sensitivity and specificity. The primary search string was constructed as follows: ("green technology" OR "educational technology" OR "digital learning tools" OR "eco-friendly education") AND ("English language teaching" OR "ELT" OR "TESOL" OR "English language pedagogy") AND ("Saudi Arabia" OR "Gulf Cooperation Council" OR "Vision 2030" OR "Arab world") AND ("sustainability" OR "sustainable development" OR "education for sustainable development" OR "ESD" OR "ecological literacy"). The search was restricted to publications in English, covering the period from January 2015 to December 2025, a timeframe which is enough to capture the decade of most significant growth in GT discourse within education, coinciding with the increasing global prominence of the United Nations' Sustainable Development Goals (UNESCO, 2017).

3.3 Inclusion Criteria

This study ensures the relevance, quality, and consistency of the included literature, by explicitly adding inclusion and exclusion criteria. These criteria were established prior to the commencement of the search in accordance with best practice in SLR methodology (Creswell & Creswell, 2018; Gough et al., 2017). Studies have been included if they met all of the following criteria: (1) they were published in peer-reviewed academic journals, conference proceedings, or as doctoral dissertations; (2) they were written in English; (3) they had a primary or substantial focus on Saudi Arabia or the broader Gulf Cooperation Council (GCC) region; (4) they addressed the integration of green technology, digital tools, or sustainability-oriented pedagogical frameworks within English language teaching or learning; and (5) they were published between 2015 and 2025. The Figure.1 depicts the inclusion criteria of the articles.

3.4 Exclusion Criteria

By contrast, studies have been excluded if they: (1) focused exclusively on green technology in non-ELT educational contexts without reference to language learning outcomes; (2) were limited to opinion pieces, editorials, or non-peer-reviewed grey literature; (3) were not accessible in full-text form; or (4) addressed sustainability in education without any specific engagement with technology or language pedagogy. These criteria were operationalised consistently across all phases of the screening process to ensure methodological integrity and inter-reviewer reliability (Kitchenham & Charters, 2007). The Figure.2 is the visual

depiction of exclusion criteria of the articles studied for this research.

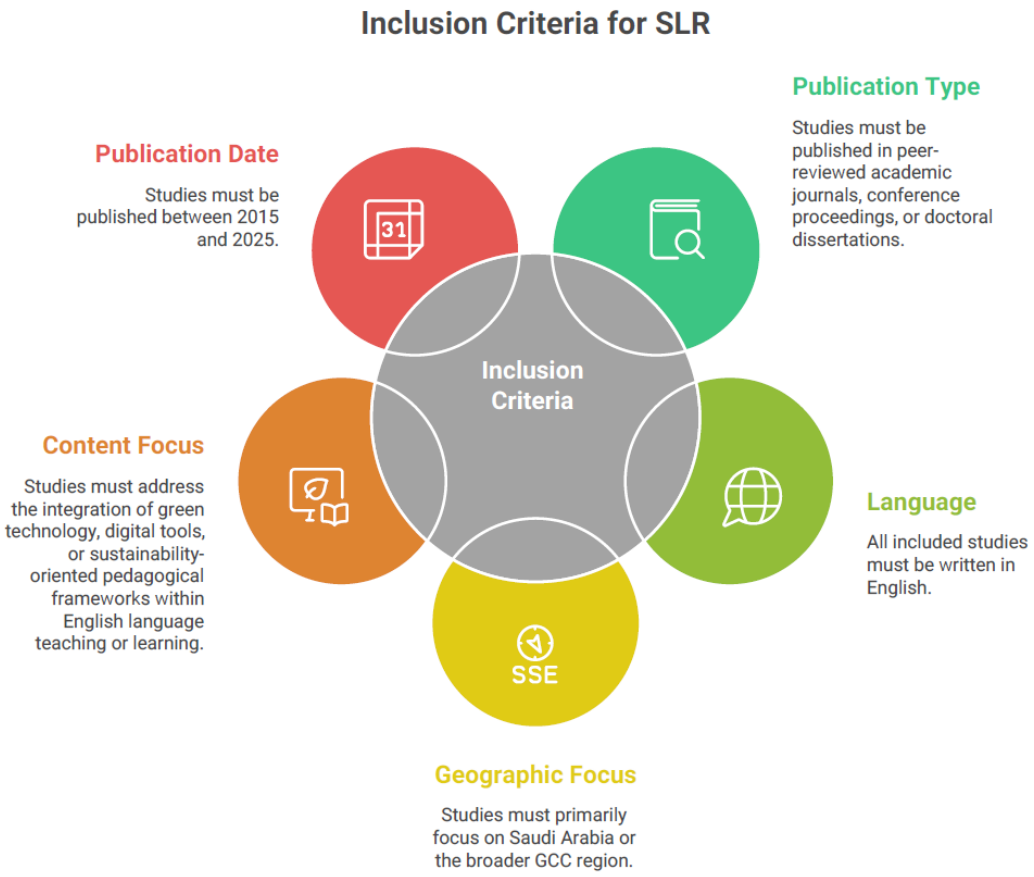

Fig.1: Inclusion criteria of the articles considered

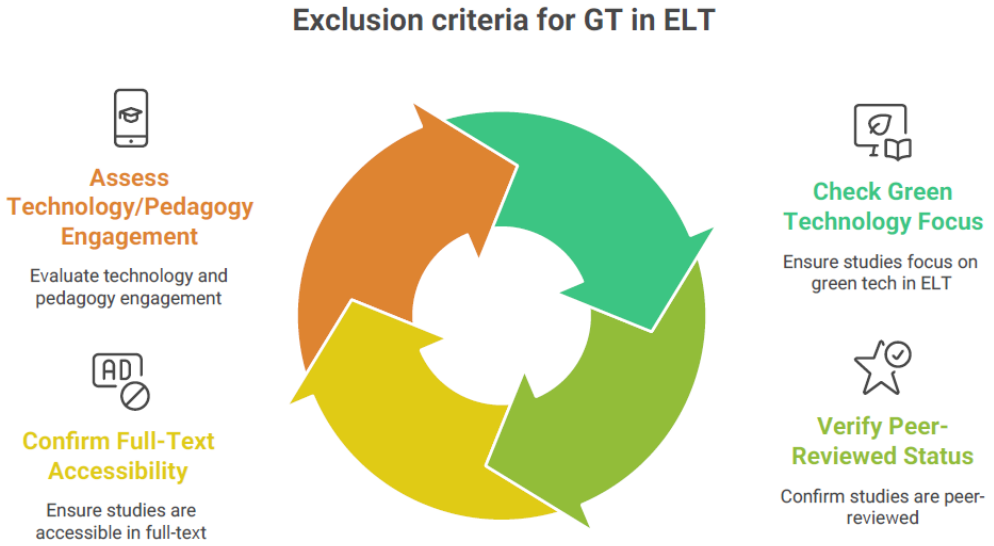

Fig.2: Exclusion criteria of the studied articles for the study

3.5 Screening and Selection Process

The screening and selection of studies was conducted in two sequential phases, following the PRISMA 2020 guidelines (Page et al., 2021). In the first phase, titles and abstracts of all records retrieved through the database search were independently screened by two co-reviewers against the predefined inclusion and exclusion criteria. Records that were clearly irrelevant—for instance, those addressing green technology in industrial engineering or sustainability in non-educational contexts—were excluded at this stage. Any record for which relevance was uncertain because of title and abstract alone was retained for full-text review.

In the second phase, full-text versions of the retained records were retrieved and subjected to a more thorough assessment against the complete set of criteria. Finally, 14 papers (as in Diagram 3) were valid for analysis. Disagreements between reviewers regarding inclusion or exclusion decisions were resolved through structured discussion and, where necessary, consultation with a third independent reviewer was done. The complete screening and selection process is documented in a PRISMA 2020 flow diagram (Page et al., 2021), which details the number of records identified, screened, assessed for eligibility, and ultimately included in the review. The final corpus comprised 14 studies meeting all inclusion criteria.

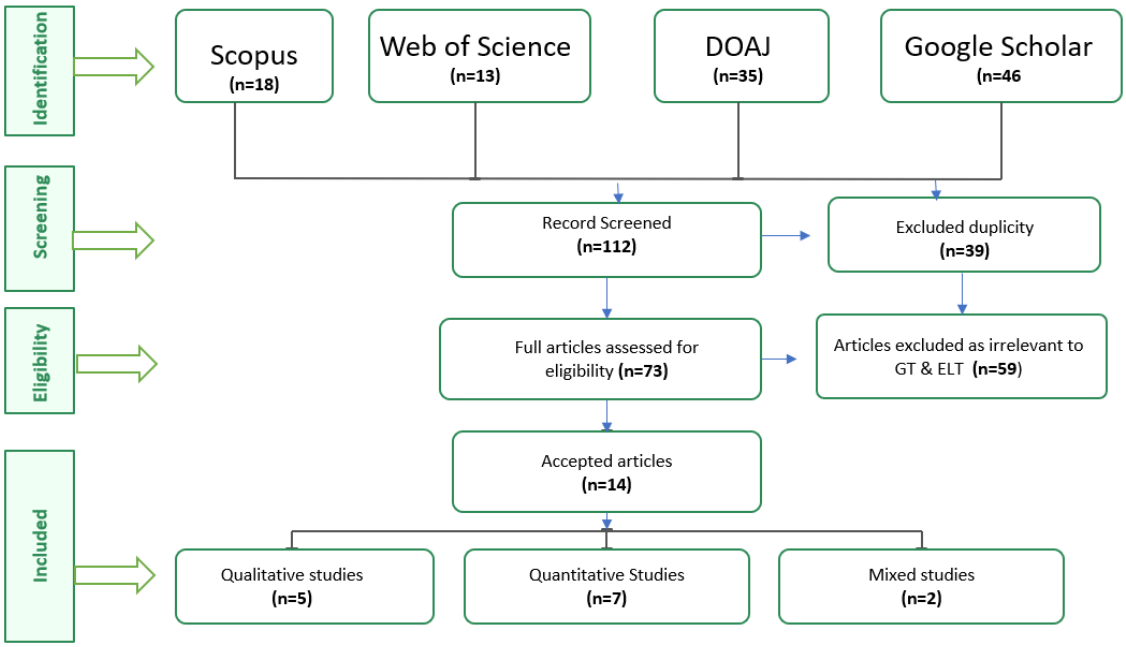

Fig.3: PRISMA flow diagram of the studied articles

3.6 Data Extraction and Synthesis

A standardised data extraction template was developed collaboratively by the investigator and applied consistently across all included studies. For each study, the following information was extracted: author(s) and year of publication; research context (country, educational level, and institutional setting); type of green technology or digital tool examined; key findings pertaining to linguistic outcomes; key findings pertaining to sustainability or ecological literacy outcomes; theoretical or conceptual frameworks employed; and methodological limitations acknowledged by the original authors. This systematic extraction process ensures comparability across studies and facilitates the identification of convergent patterns in the evidence base (Gough et al., 2017).

Thematic synthesis involves three iterative stages: the initial coding of findings from each study using inductive free codes; the organisation of these free codes into descriptive themes accurately reflecting the content of the primary studies; and the development of analytical themes that generate higher-order interpretations capable of answering the review's research questions (Braun & Clarke, 2006). This process has yielded four primary themes—conceptual frameworks, practical applications, challenges and barriers, and implications for the Saudi Arabian context—which form the organisational basis for the findings presented in Section 4.

IV. FINDINGS

The systematic review process yielded a final corpus of 14 studies that have met all inclusion criteria and been drawn

from the five databases searched. The included studies spanned a range of methodological traditions, which encompass qualitative case studies, quantitative designs, mixed-methods approaches, and conceptual framework analyses; they reflect the diverse scholarly approaches that have been brought to bear on the phenomenon of GT integration in ELT. All four themes identified through thematic synthesis are discussed in turn below.

4.1 Conceptual Frameworks of GT in ELT

The review identified a coherent and growing body of conceptual frameworks specifically developed to structure the integration of green technology into English language pedagogy. Most prominently, the green language teaching approach (GLTA), which is articulated by Nur et al. (2022); it has emerged as a foundational framework, emphasising the embedding of sustainability themes within language curricula to enable learners to develop both English language proficiency and ecological literacy in a mutually reinforcing manner. GLTA draws explicitly on content-based instruction principles to ensure that environmental topics—such as renewable energy, climate change, and waste management—function as authentic and meaningful contexts for language use rather than as peripheral additions to an otherwise unchanged syllabus (Chapelle, 2003; Nur et al., 2022).

Complementing GLTA, the context-aware ubiquitous language learning (CAULL) framework, as described by Wang et al. (2019), leverages mobile technologies, GPS-enabled sensing systems, and augmented reality interfaces to create dynamically contextualised learning environments. Studies employing CAULL reported measurable improvements in both vocabulary acquisition and environmental knowledge, suggesting that the integration of ecological content does not compromise linguistic outcomes but may, in fact, enhance them through increased motivation and contextual relevance (Pegrum, 2014; Wang et al., 2019). Together, these frameworks signal a substantive shift in ELT philosophy—one that positions the English language classroom as a site of critical environmental awareness, engagement, and communicative skill development.

4.2 Practical Applications of GT in ELT

The review documented a diverse array of practical applications of GT in ELT settings, spanning digital resource adoption, project-based learning, and immersive technology integration. The transition from printed to digital learning materials—including e-textbooks, cloud-based assignments, and online assessment platforms—was consistently reported as the most widely implemented GT application in ELT. In this regard, Suryawanshi and Narkhede (2015) document significant reductions in paper consumption and associated institutional costs following digital transitions. Virtual classrooms and synchronous online learning platforms similarly reduced the demand for physical infrastructure whilst maintaining, and in some cases enhancing, the quality of language instruction (Alhumaid et al., 2020).

Furthermore, project-based language learning with technology (PBLLT) proved particularly effective in promoting substantive engagement with environmental issues alongside genuine communicative development (Widodo, 2015). Students participating in digitally mediated community projects, such as producing English-language environmental awareness videos, conducting surveys on local water usage, or designing multilingual recycling campaigns, demonstrated enhanced critical thinking, collaborative communication skills, and ecological awareness. The use of green screens and virtual reality environments further enriched ELT by enabling teachers to simulate ecologically significant scenarios—such as coral reef degradation or desertification processes—making abstract environmental concepts viscerally accessible and linguistically generative. Social media platforms were additionally identified as emergent GT-aligned learning environments through which learners practise English whilst disseminating eco-conscious content to real audience members (Hussain, 2023).

4.3 Challenges in Adopting GT in ELT

Despite the compelling evidence for GT's pedagogical and environmental benefits, this SLR reveals persistent and significant barriers to its broad-scale adoption in ELT. Financial constraints emerged as the most consistently cited obstacle across the included studies, with the initial capital investment required for digital infrastructure, device procurement, and platform licensing; these altogether represent a prohibitive barrier for many institutions, particularly those operating in resource-constrained settings (Alhumaid et al., 2020).

Limited teacher preparedness was also prominently featured, with multiple studies reporting that educators lacked not only the technical skills to operate GT tools effectively but also the pedagogical knowledge to integrate them in ways genuinely aligned with sustainability objectives rather than merely superficially digital (Alkahtani, 2017). Institutional resistance to pedagogical change emerged as a third critical barrier, which reflects deep-seated norms that privileges examination-oriented, teacher-centred instruction over experiential, project-based, and technologically mediated approaches (Alkahtani, 2017). The scarcity of localised, culturally relevant GT teaching materials designed specifically for the Saudi Arabian ELT context was also identified as a significant

practical impediment, suggesting that even where institutional willingness and financial resources exist, the available toolkit may be insufficiently adapted to local needs.

4.4 Implications for Saudi Arabia

The findings carry substantial and specific implications for GT integration in Saudi Arabia's ELT sector. Vision 2030 provides an unusually supportive policy environment for GT adoption, given its explicit commitments to educational reform, digital transformation, and environmental sustainability (Saudi Vision 2030, 2016). This SLR's findings suggest that this enabling environment, combined with the country's significant investment in educational technology infrastructure, positions Saudi Arabia well to pioneer contextually adapted GT integration in ELT at a national scale. However, the persistent challenges identified in the literature indicate that policy commitment and financial investment alone are insufficient. Sustained, context-specific professional development programmes, the co-development of Saudi-specific GT teaching resources, and the creation of institutional incentive structures that reward innovative and sustainable pedagogy are all essential components of an effective national GT-in-ELT strategy (Hamdan & Romli, 2021; Alkahtani, 2017).

V. DISCUSSION

The integration of GT in English language pedagogy represents far more than a technological upgrade to existing instructional practice; it constitutes a substantive reorientation of the pedagogical purpose of language education towards the broader imperatives of education for sustainable development (UNESCO, 2017). The following discussion synthesises the review's findings in relation to the three guiding research questions, situates them within the wider scholarly literature, and addresses the practical, theoretical, and policy implications for Saudi Arabia and for the global ELT community.

5.1 Aligning ELT with Sustainability Goals

The first research question enquired into the conceptual frameworks available to guide GT integration in ELT. The review's findings confirm that frameworks such as GLTA and CAULL demonstrate that language classrooms can serve as sites of genuine ecological inquiry when teachers are equipped with both the conceptual tools and the technological resources to facilitate this integration (Nur et al., 2022; Wang et al., 2019). This finding resonates strongly with Hockly's (2019) argument that sustainable development is not merely a thematic addendum to ELT but a transformative philosophical orientation that should inform curriculum design, materials development, and assessment practice. The evidence further confirms Warschauer's (2011) contention that the most powerful technology-enriched language education is that which is purposefully anchored in socially meaningful real-world contexts.

In the Saudi Arabian context, this alignment assumes urgency given the country's well-documented environmental pressures and its policy-level commitment to sustainability under Vision 2030 (Alkahtani, 2017; Saudi Vision 2030, 2016). ELT, as one of the most extensively resourced and institutionally embedded disciplines in Saudi foreign language education, is strategically poised to serve as a vehicle for cultivating an environmentally aware generation of citizens capable of engaging with ecological challenges in a globally connected language (Alalwan et al., 2019).

5.2 Practical Applications and Innovations

The second research question addressed the practical applications and innovations documented in the literature. This SLR's findings reveal a diverse and increasingly sophisticated repertoire of GT-enhanced pedagogical practice. Particularly noteworthy is the evidence base for project-based approaches, which consistently demonstrate multi-dimensional learning outcomes extending beyond linguistic competence to encompass critical thinking, collaborative problem-solving, and genuine environmental agency (Widodo, 2015; Hussain, 2023). This multi-dimensional outcome profile addresses a long-standing critique of ELT that it prioritises narrow linguistic metrics at the expense of holistic educational development (Chapelle, 2003).

The emergence of AI-driven personalised learning platforms represents perhaps the most transformative frontier in GT-enhanced ELT, offering the prospect of highly differentiated instruction that adapts in real time to individual learner profiles whilst simultaneously reducing the ecological cost of print-based assessment (Nur et al., 2022). Saudi Arabia's advanced digital infrastructure and its demonstrated willingness to invest in cutting-edge educational technology suggest that the country is well-placed to be an early and innovative pioneer of these emerging applications. The findings indicate, however, that the effective realisation of these applications' potential is contingent upon robust teacher preparation programmes that build both technical competence and pedagogical confidence (Hamdan & Romli, 2021).

5.3 Challenges and Barriers

The third research question investigated into the challenges and barriers that persist in GT integration. The challenges identified are financial constraints, limited teacher preparation, institutional resistance, and a scarcity of

localised materials. These are not unique to Saudi Arabia but represent a global pattern in the adoption of pedagogical innovation. What is distinctive about the Saudi context, however, is the intersection of significant financial resources and leadership will, on one hand, with deeply entrenched pedagogical traditions and a historically examination-focused educational culture, on the other (Alalwan et al., 2019).

The evidence strongly suggests that financial investment in hardware and platforms, whilst necessary, is insufficient in isolation. Studies consistently identify teacher agency, preparedness, and pedagogical understanding as the determining factors in whether GT integration enhances or merely digitises existing practice (Alhumaid et al., 2020).

5.4 Future Directions

The review's findings point to several priority areas for future research and practice. Longitudinal studies examining the long-term impacts of GT-enhanced ELT on both language learning outcomes, environmental attitudes, and behaviours are conspicuously absent from the existing literature and represent an important research gap. In addition, the development and empirical evaluation of locally adapted GT frameworks and materials—especially designed for the linguistic, cultural, and environmental realities of the Saudi Arabian context—is identified as a critical research and development priority (Hamdan & Romli, 2021).

Emerging technologies, including the Internet of Things (IoT), advanced AI tutoring systems, and mixed reality environments offer particularly rich possibilities for future GT-enhanced ELT that have yet to be systematically explored in the literature. Future research might also productively examine the role of student voice and agency in GT-enhanced ELT to explore how learners themselves conceptualise the relationship between their English language education and their responsibilities as environmental citizens. Such research would not only enrich the theoretical foundations of GT-enhanced ELT but also ensure that the field's future development is informed by the perspectives and experiences of the learners it ultimately serves (Hockly, 2019).

VI. CONCLUSION

This SLR has presented a comprehensive synthesis of the existing evidence on the integration of green technology in English language teaching in Saudi Arabia; it has been organised around three major themes: conceptual frameworks, practical applications, challenges and barriers alongside implications for the Saudi ELT context. The findings affirm that GT integration in ELT is not merely a pedagogical trend but a principled and increasingly well-evidenced response to the dual imperatives of language education efficacy and environmental sustainability. Frameworks such as the green language teaching approach and context-aware ubiquitous language learning provide coherent and operationalisable blueprints for embedding ecological literacy within English language education, whilst practical applications ranging from digital resource adoption to project-based learning and immersive simulation offer a growing and flexible repertoire of GT-enhanced instructional strategies.

Saudi Arabia's Vision 2030 framework provides an encouraging policy environment of unusual strength and ambition for GT integration in ELT. The Kingdom's substantial investments in educational technology, its explicit sustainability commitments, and its environmental challenges collectively create a context in which GT-enhanced ELT is not simply desirable but arguably imperative. However, this SLR's findings make clear that realising the full transformative potential of GT in Saudi ELT will require a coordinated, multi-stakeholder effort that addresses the persistent barriers of insufficient teacher preparation, scarce localised materials, and institutional resistance to change.

The field seems at a promising time ahead. The convergence of rapidly advancing digital technologies, growing institutional commitment to sustainability, and maturing body of scholarly evidence creates conditions in which GT-enhanced ELT can become not an exception but a norm, which can serve as a standard component of high-quality, socially responsible English language pedagogy. This SLR sheds light on that work while its findings will inform the continued development of evidence-based, contextually adapted, and pedagogically rigorous GT-enhanced ELT in Saudi Arabia and in comparable educational contexts across the globe.

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