

Green Literacy in the AI Era: Empowering Global Citizenship through SDG Integration in AI-Assisted EFL Curricula

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Abstract. This study investigates how integrating Sustainable Development Goal (SDG)-related content via AI-assisted tools supports the enhancement of EFL learners' language motivation within a Green Literacy framework. A mixed-methods design was employed with 30 intermediate EFL university students over 12 weeks. Quantitative data were collected through pre- and post-program Likert-scale surveys measuring self-reported confidence in discussing global issues in English, while qualitative data were gathered via semi-structured interviews and classroom observations. Survey results revealed a statistically significant increase in student confidence (from 40% to 80%; $p < .05$ on paired t-test). Thematic analysis of interviews identified three core patterns: increased motivation, reduced language anxiety, and greater perceived relevance of English for global advocacy. The findings suggest that AI tools function as adaptive scaffolds, enabling learners to engage with complex sustainability discourse while simultaneously developing communicative competence. This study contributes an empirically grounded model for integrating SDGs and AI in EFL instruction.

Keywords: AI-assisted language learning; EFL; Global Citizenship Education; Green Literacy; Sustainable Development Goals

1 Introduction

Contemporary English as a Foreign Language (EFL) instruction faces a dual imperative: developing learners' communicative competence while preparing them to participate meaningfully in addressing global challenges (UNESCO, 2021). The United Nations' 2030 Agenda for Sustainable Development, embodied in the 17 Sustainable Development Goals (SDGs), has positioned education as a central mechanism for fostering the knowledge, skills, and values necessary for sustainable development (United Nations, 2015). Yet research on how language classrooms can systematically contribute to SDG-oriented outcomes—particularly through emerging instructional technologies—remains limited.

The rapid proliferation of Artificial Intelligence (AI) tools in educational contexts offers new possibilities for personalized and adaptive language learning (Zawacki-Richter et al.,

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2019). AI platforms can tailor content to individual learner profiles, provide real-time feedback, and scaffold engagement with complex thematic material (Chiu et al., 2023). Despite this potential, few empirical studies have examined how AI-mediated instruction can simultaneously advance language proficiency and sustainability literacy within a cohesive pedagogical framework.

A specific gap exists at the intersection of three domains: AI-assisted EFL instruction, SDG-integrated curricula, and Green Literacy as an evaluative framework. While scholars have examined AI in language learning (Huang et al., 2023) and SDGs in higher education (Leal Filho et al., 2021) as separate lines of inquiry, the synergistic integration of these domains in EFL practice has not been empirically investigated. This study addresses that gap.

The primary research question guiding this study is: To what extent does the integration of SDG-related content via AI-assisted instruction enhance EFL learners' self-reported language confidence and motivation in discussing global sustainability issues? Secondary questions address the specific affordances of AI tools as perceived by learners and the role of Green Literacy-aligned activities in shaping engagement.

1.1 Literature review

1.1.1 SDGs and Education for Sustainable Development

Education for Sustainable Development (ESD) has been institutionalized through UNESCO's frameworks as a transformative approach that moves beyond knowledge transmission toward the cultivation of critical thinking, collaborative problem-solving, and systems thinking (UNESCO, 2017). In EFL contexts specifically, the integration of globally relevant content has been shown to increase learner engagement and perceived relevance of language study (Dooly & Vinagre, 2022). SDG-focused content—spanning climate action (SDG 13), quality education (SDG 4), and related goals—provides authentic, high-interest material that aligns with the communicative purpose of language learning.

Coyle et al. (2017) argued that transforming passive classrooms into active, content-rich learning environments requires substantive thematic anchors. SDGs serve precisely this function, providing a globally recognized framework that connects language tasks to real-world outcomes. The integration of SDGs also supports the development of global citizenship identity, which Lozano et al. (2013) identified as a core outcome of sustainability education.

1.2 AI in Language Education

The application of AI in language education has expanded considerably, with research documenting its role in personalizing learning pathways, delivering adaptive feedback, and scaffolding engagement with complex content (Chiu et al., 2023; Zawacki-Richter et al., 2019). Kukulska-Hulme et al. (2020) highlighted flexible, technology-mediated practice as particularly valuable for learners with varying proficiency levels and learning pace preferences. Importantly, AI tools can reduce anxiety by providing low-stakes practice environments where learners interact with challenging material without the pressure of immediate peer or teacher evaluation.

Huang et al. (2023) conducted a systematic review of personalized AI-assisted learning for EFL, finding consistent positive associations with motivation and self-efficacy. Kohnke & Moorhouse (2022) similarly documented increased engagement in technology-enhanced EFL environments. However, existing studies have predominantly focused on AI as a tool for grammar and vocabulary acquisition rather than thematic or content-based instruction aligned with broader social goals.

1.3 Green Literacy as a Framework

Green Literacy is defined as the integrated knowledge, skills, and values required to understand, analyze, and respond to environmental challenges (Leicht et al., 2018). As operationalized in this study, Green Literacy encompasses three dimensions: systems thinking (understanding causal relationships in environmental systems), critical reflection (evaluating sustainability claims and policy options), and empowered action (developing capacity and motivation to advocate for change). This framework aligns closely with Dörnyei (2009) L2 Motivational Self System, particularly the notion of the ‘ideal L2 self’—in this context, a learner who envisions using English as a tool for global advocacy.

Fernández Galeote et al. (2021) highlighted the potential of games and gamified digital approaches to foster engagement and education on climate-change issues. Incorporating Green Literacy into EFL instruction can therefore extend the pedagogical value of language learning by connecting communicative development with environmental awareness, civic responsibility, and sustainability-oriented competence.

1.4 Research Gap

While previous research has examined AI in EFL and SDGs in higher education as discrete areas, empirical studies integrating all three constructs—AI-assisted instruction, SDG content, and Green Literacy—within a single EFL curriculum design are absent from the literature. This study addresses this gap by providing empirical evidence of the outcomes of such an integrated approach.

2 Method

2.1 Research Design

This study employed a mixed-methods design, combining quantitative pre- and post-program surveys with qualitative semi-structured interviews and classroom observations. The integration of methods enabled triangulation of findings: survey data provided measurable indicators of confidence change, while interview and observational data illuminated the experiential and motivational dimensions of learning.

2.2 Participants

Participants were 30 EFL students (aged 16–20) enrolled in an English course at a private university in Indonesia. All participants were assessed at the B1 (intermediate) level of the Common European Framework of Reference for Languages (CEFR) prior to the study. A purposive sampling strategy was employed to ensure participants had sufficient prior English proficiency to engage meaningfully with SDG content while remaining within the target development range for the intervention. The relatively small sample size is acknowledged as a limitation; a statistical power analysis indicated that $n = 30$ is sufficient to detect a medium effect size ($d = 0.5$) at $\alpha = .05$ with power = .80 in a one-group pre-post design. Future research should replicate findings with larger, more diverse samples.

2.3 Instructional Materials and Learning Media

The 12-week curriculum integrated SDG-related content through specific platform like ChatGPT for the role-plays and debates. It is important to clarify that these tools functioned

as learning media—vehicles for delivering and scaffolding content—rather than as research instruments. The research instruments are described separately in Section 2.4.

SDG content was embedded through four activity types: (1) structured debates on climate action scenarios (SDG 13), (2) role-play simulations addressing educational equity (SDG 4), (3) group projects requiring students to develop local sustainability proposals, and (4) case study analyses of real-world environmental policies. All activities were designed using the Green Literacy framework to ensure alignment between language tasks and sustainability competence development. The curriculum was developed in consultation with the Green Literacy dimensions outlined by Leicht et al. (2018) and reflected principles of Project-Based Learning as described by Beckett & Slater (2005).

2.4 Research Instruments

Quantitative data were collected using a 10-item Likert-scale survey (1 = strongly disagree, 5 = strongly agree) administered before and after the 12-week program. The survey measured self-reported confidence in using English to discuss environmental and global issues. Content validity was established through expert review by three EFL specialists and one sustainability education scholar, who evaluated item relevance and clarity. Construct validity was assessed through exploratory factor analysis, which yielded a single-factor solution accounting for 61% of variance. Internal consistency was high (Cronbach's $\alpha = .87$ at pre-test; $\alpha = .89$ at post-test).

Qualitative data were gathered through semi-structured interviews conducted with a purposive subsample of 10 participants selected to represent variation in confidence change scores. Interview questions explored learners' experiences with the AI tools, their engagement with SDG content, and their perceptions of English as a tool for global advocacy. Interview guides were piloted with two students not included in the main study and revised for clarity. Interviews were audio-recorded, transcribed verbatim, and translated from Indonesian to English by a bilingual research assistant. Member-checking was conducted by sharing transcripts with participants to verify accuracy.

Classroom observations were recorded using a structured observation protocol focused on indicators of student engagement (verbal participation frequency, collaboration patterns, and on-task behavior) during SDG-related activities.

2.5 Data Analysis

Quantitative analysis involved a paired-samples t-test comparing pre- and post-program survey scores to evaluate the statistical significance of confidence change. Effect size was calculated using Cohen's *d*. Descriptive statistics (means, standard deviations) are reported for both time points.

Qualitative data from interviews were analyzed using thematic analysis following the six-phase procedure described by Braun & Clarke (2006): familiarization, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Two independent coders analyzed a randomly selected 30% of transcripts; inter-rater reliability was calculated at $\kappa = .81$, indicating strong agreement. Classroom observation data were analyzed descriptively to corroborate interview findings.

3 Results and Discussion

3.1 Results

3.1.1 Quantitative Findings: Survey Analysis

Pre-program survey scores indicated that 40% of participants ($n = 12$) reported feeling confident using English to discuss environmental topics (mean score ≥ 3.5 on the 5-point scale; $M = 3.12$, $SD = 0.61$). Post-program scores showed a substantial increase, with 80% of participants ($n = 24$) reporting confidence at or above the threshold ($M = 4.21$, $SD = 0.47$). A paired-samples t-test confirmed that this improvement was statistically significant, $t(29) = 8.34$, $p < .001$, $d = 1.52$ (large effect). The magnitude of improvement indicates substantive gains attributable to the 12-week intervention, though the absence of a control group limits causal attribution.

Table 1. Pre- and Post-Program Confidence Levels

Metric	Pre-Test	Post-Test
Confidence Percentage (Score ≥ 3.5)	40% ($n = 12$)	80% ($n = 24$)
Mean	3.12	4.21
Standard Deviation	0.61	0.47

3.1.2 Qualitative Findings: Thematic Analysis

Thematic analysis of interview transcripts identified three core themes: (1) increased motivation through content relevance, (2) reduced language anxiety via AI scaffolding, and (3) development of a global advocacy identity.

Theme 1: Increased Motivation through Content Relevance. Participants consistently reported that engaging with sustainability topics increased their motivation to use English. One participant explained that when the language was connected to real problems, the motivation to find the right words became much stronger. Another noted that learning about climate change gave a real purpose to English, beyond merely preparing for tests. These responses reflect the pattern Dörnyei (2009) identified regarding content that activates an ‘ideal L2 self’ linked to global citizenship.

Theme 2: Reduced Language Anxiety via AI Scaffolding. Several participants described AI tools as providing a low-pressure environment for engaging with difficult vocabulary and concepts. One participant noted that the AI tool allowed practicing difficult terms about sustainability repeatedly without feeling embarrassed in front of classmates. This finding aligns with Wu et al. (2026), who found that incorporating AI chatbots into EFL activities reduced learners’ foreign language speaking anxiety and enhanced their language enjoyment and speaking performance.

Theme 3: Development of a Global Advocacy Identity. By the end of the program, many participants articulated a shift in their perceived relationship with English—from a school subject to a medium for civic participation. One participant reflected: Before this course, I never imagined discussing global issues in English, but now I feel I can share my views on climate action. Classroom observations corroborated this theme, showing increased voluntary participation in SDG debates and more sustained peer collaboration in group sustainability projects.

3.1.3 Classroom Observations

Structured observation data indicated progressive increases in voluntary verbal participation over the 12-week period, with mean participation frequency rising from 2.3 instances per student per session in weeks 1–4 to 5.7 instances in weeks 9–12. Collaborative behavior (peer discussion and shared problem-solving during group projects) also increased substantially. Teachers reported that AI tools supported differentiated engagement, allowing lower-confidence students to prepare independently before contributing to group discussions.

3.2 Discussion

The findings of this study provide empirical support for the value of integrating AI-assisted instruction, SDG content, and Green Literacy-oriented activities in EFL curricula. The statistically significant improvement in self-reported confidence ($t(29) = 8.34, p < .001, d = 1.52$) aligns with and extends prior research on AI-mediated language learning (Chiu et al., 2023; Huang et al., 2023) by demonstrating that these gains occur in the context of thematically rich, sustainability-focused content rather than conventional grammar-oriented instruction.

The large effect size warrants interpretive caution given the study's limitations (discussed below), but it is consistent with the scope of the intervention—12 weeks of immersive, scaffolded engagement with motivationally salient content. The qualitative findings offer a mechanistic explanation: participants reported that AI tools reduced anxiety, and that SDG content activated a form of instrumental motivation tied to global citizenship aspirations. This is consistent with Dörnyei (2009) L2 Motivational Self System, in which the ideal L2 self—here, a student who uses English for environmental advocacy—functions as a potent motivational driver.

The three qualitative themes (content relevance, anxiety reduction, advocacy identity) converge on a picture of the AI-assisted, SDG-integrated classroom as a context in which language learning becomes purposeful and identity-affirming. Furthermore, these findings directly map onto the core dimensions of the Green Literacy framework. The development of a 'global advocacy identity' provides empirical evidence for the empowered action dimension, while learners' motivated engagement with complex environmental content demonstrates active systems thinking and critical reflection.

Compared to Kohnke & Moorhouse's (2022) findings on technology-enhanced EFL engagement, the present study shows that affective benefits of AI tools are amplified when the content itself carries civic significance. This suggests that content selection is not merely a pedagogical consideration but a motivational variable with measurable effects on confidence and participation.

Several limitations temper these conclusions. The absence of a control group precludes causal attribution; observed gains may reflect general development over the semester, instructor effects, or participant selection factors. The sample was drawn from a single private university in Indonesia, limiting generalizability. Self-reported confidence surveys may be subject to social desirability bias, and the translation of qualitative data from Indonesian introduces potential interpretive shifts. Future research should employ control group designs, larger and more diverse samples, and objective performance-based measures alongside self-report data.

4 Conclusion

This study examined the integration of SDG content and AI-assisted learning tools within an EFL curriculum framed by the Green Literacy framework. Over 12 weeks, 30 intermediate

EFL learners showed statistically significant gains in self-reported language confidence ($p < .001$, $d = 1.52$), alongside qualitative evidence of increased motivation, reduced anxiety, and the emergence of a global advocacy identity. These findings contribute to a nascent but growing body of research at the intersection of AI-mediated instruction, sustainability education, and EFL pedagogy.

The practical implications are clear: EFL instructors can meaningfully incorporate SDG-related content using accessible AI platforms without sacrificing language development objectives—and may in fact amplify motivation and confidence by doing so. The Green Literacy framework provides a principled basis for designing activities that develop both communicative and sustainability competence simultaneously.

Future research should address the limitations of the present study by employing experimental or quasi-experimental designs, diversifying participant samples across institutional and national contexts, and incorporating objective language proficiency measures alongside self-report instruments. Longitudinal designs would clarify whether the motivation and identity changes observed here are durable beyond the intervention period.

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