

Exploring SDG-Themed Project-Based Writing to Improve EFL Students' Sustainability Awareness and Academic Writing Performance

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Abstract

The integration of Education for Sustainable Development (ESD) into English Language Teaching (ELT) has become increasingly important in preparing students to respond to complex global challenges. However, empirical evidence regarding the effectiveness of SDG-themed Project-Based Writing in developing both sustainability awareness and academic writing competence among EFL learners remains limited. This study investigates the effect of SDG-themed Project-Based Writing on environmental sustainability awareness and academic writing performance among undergraduate EFL students. A pre-experimental one-group pretest-posttest design was employed involving 42 students enrolled in an Academic Writing course at an Indonesian university. Data were collected using an Environmental Sustainability Awareness Questionnaire and an analytic academic writing rubric assessing text organization, coherence and cohesion, language accuracy, academic resource use, and argumentation quality. Data were analyzed using descriptive statistics, paired-samples t-test, Wilcoxon Signed-Rank Test, and Cohen's d effect size analysis. The findings revealed a significant improvement in students' sustainability awareness ($t(41) = -5.95$, $p < .001$, $|d| = 1.119$), with the largest improvement occurring in sustainability knowledge. Academic writing performance also improved significantly ($Z = -5.651$, $p < .001$, $|d| = 1.585$), particularly in academic source utilization, text organization, and argumentation quality, whereas language accuracy showed minimal change. These findings indicate that SDG-themed Project-Based Writing provides an effective pedagogical approach for integrating sustainability education with EFL academic writing development.

Keywords: Education for sustainable development; Sustainable development goals; Project-based writing; Environmental sustainability awareness; Academic writing performance

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INTRODUCTION

In the 21st century, higher education institutions are expected not only to produce academically competent graduates but also to contribute to the achievement of the Sustainable Development Goals (SDGs), particularly those related to environmental sustainability. University students, as future professionals and agents of change, play a crucial role in shaping a more sustainable future. Nevertheless, many of them still perceive sustainability issues merely as theoretical concepts rather than practical concerns that should be implemented in everyday life (Leal Filho et al., 2019). In the context of English language learning, this situation can be seen as a valuable opportunity

to integrate sustainability themes into classroom activities. One promising approach is through writing projects that engage students in solving real-world problems relevant to their lives.

Writing functions not only as a medium for expressing ideas linguistically but also as a cognitive and affective process that encourages learners to think critically, reflect, construct arguments, and take action (Jasman et al., 2025; Yin et al., 2023; Dewi et al., 2023). Within this framework, Project-Based Learning (PBL) offers a powerful approach to connecting language use with meaningful social issues. Through PBL, students are encouraged to investigate authentic problems, collaborate with peers, and produce tangible outcomes that create impacts beyond the classroom (Thomas, 2000; Stoller, 2006). When such projects are linked to environmental SDG themes, writing becomes more than an academic exercise; it transforms into a learning process that fosters social awareness and responsibility toward the planet we inhabit.

Environmental issues such as climate change, pollution, and waste management are not isolated problems. They are interconnected and require interdisciplinary understanding. Therefore, integrating these themes into English language learning aligns with emerging educational approaches, particularly Content and Language Integrated Learning (CLIL) and Education for Sustainable Development (ESD). Both approaches emphasize the importance of combining linguistic learning outcomes with the development of critical thinking, ethical awareness, and global consciousness (UNESCO, 2020; Coyle et al., 2010). Through writing projects focused on environmental SDGs, students not only learn to compose well-structured academic texts but are also trained to critically analyze environmental issues, propose realistic solutions, and promote awareness within the campus environment and broader society.

Previous studies generally indicate that SDG-oriented Project-Based Learning (PBL) has been widely implemented to foster sustainability awareness and enhance 21st-century skills across diverse contexts and focuses. Several studies have reported that PBL applied in English language learning—whether in the contexts of English for Academic Purposes (EAP), English for Professional Purposes (ESP), or English as a Foreign Language (EFL)—can significantly improve students' communication skills, critical thinking, and socio-environmental awareness (Yusupova et al., 2025; Nanni & Allan, 2020; Ruiz et al., 2024; Chen et al., 2022). Meanwhile, other studies have focused more on primary education contexts and the integration of technology in sustainability education (Ribis, 2024).

Although the effectiveness of PBL in supporting SDG achievement has been demonstrated across various educational settings, studies specifically implementing project-based writing centered on environmental SDG themes in higher education remain very limited. This gap is what the present study seeks to address by analyzing the extent to which SDG-themed Project-Based Writing improves EFL students' environmental sustainability awareness and academic writing performance.

METHOD

Research Design

This study employed a pre-experimental one-group pretest–posttest design to investigate the effectiveness of SDG-themed Project-Based Writing in enhancing EFL students' environmental sustainability awareness and academic writing performance. In this design, participants were assessed before and after the implementation of the instructional intervention to identify changes in their knowledge, attitudes, practices, and writing abilities. The pretest served as a baseline measurement to determine students' initial levels of environmental sustainability awareness and academic writing

competence, while the posttest was administered after the intervention to evaluate the extent of improvement resulting from the learning experience.

The selection of this research design was based on the authentic conditions of classroom-based educational research, where researchers often work within existing learning environments and face practical limitations in randomly assigning students to experimental and control groups. As noted by Cohen (2018), pre-experimental designs are appropriate for investigating instructional innovations in real educational settings, particularly when the primary objective is to examine the potential impact of a teaching approach. Through the integration of project-based learning activities centered on Sustainable Development Goals (SDGs), students were engaged in meaningful writing projects that connected environmental issues with language learning. Although the absence of a comparison group limits the ability to establish strong causal relationships, the pretest–posttest approach provides valuable evidence regarding students' developmental changes and the potential effectiveness of SDG-themed Project-Based Writing as an innovative EFL instructional strategy.

Participants

The study was conducted at Ma'soem University, involving students from the English Education Department in the 2025/2026 academic year as the target population. The participants were selected from the sixth-semester cohort because they were taking the *Writing for Academic Purposes* course, which is closely related to the objectives of this study. This course provides an appropriate context for implementing project-based writing activities, as students are expected to develop academic writing skills while engaging with meaningful and contextual issues. The independent variable of the study was Project-based Writing, which was implemented as an instructional approach integrating writing activities with environmental sustainability themes aligned with the Sustainable Development Goals (SDGs). Meanwhile, the dependent variables were students' environmental sustainability awareness and academic writing performance, which were measured to examine the extent to which the intervention contributed to students' cognitive, affective, and writing skill development.

Research Instruments and Data Collection

The instruments consisted of two main components. First, the environmental sustainability awareness questionnaire was administered to measure students' knowledge, attitude, practice, responsibility, as well as engagement and communication regarding environmental issues, aligned with the Education for Sustainable Development (ESD) framework (UNESCO, 2020). Second, students' academic writing performance was assessed using an analytic rubric covering text organization, coherence and cohesion, language accuracy, use of academic sources, and quality of argumentation, following the principles of academic writing assessment proposed by (Ferris and Hedgcock, 2014). Because the questionnaire was newly developed by the researcher, it was subjected to comprehensive validation procedures prior to implementation. Content and construct validity were evaluated through expert judgment, while internal consistency reliability was assessed using Cronbach's alpha. Additionally, to determine the appropriateness of parametric versus non-parametric statistical procedures, the collected survey data were tested for normality using the Kolmogorov-Smirnov or Shapiro-Wilk test.

The study was conducted in a semester following three steps: (1) distributing a questionnaire to measure students' environmental sustainability awareness and conducting a pretest to measure students' academic writing performance; (2) applying experimental treatment to the participants; (3) distributing the same questionnaire to measure students' environmental sustainability awareness and administering a posttest to

measure students' academic writing performance after receiving treatment. The differences attributed to application of the experimental treatment are then evaluated by comparing the pretest and posttest. The instructional intervention was designed based on Project-Based Learning (PBL) principles, emphasizing students' engagement in authentic problem investigation, collaboration, and the production of meaningful outcomes (Thomas, 2000 and Stoller, 2006). The integration of environmental SDG themes aimed to bridge language competence development with sustainability literacy, consistent with the paradigms of Content and Language Integrated Learning (CLIL) and Education for Sustainable Development (ESD) (UNESCO, 2026 and Coyle, 2010).

Data Analysis

The data from questionnaire were analyzed using descriptive statistics and a paired-samples t-test to determine the significance of differences before and after the intervention. However, since the writing pretest score did not meet the assumption of normality, a Wilcoxon Signed-Rank Test was conducted. In addition, effect size (Cohen's *d*) was calculated to measure the magnitude of the treatment effect, as recommended in educational experimental research (Plonsky and Oswald, 2014).

RESULTS AND DISCUSSION

Results

Improvement of Students' Environmental Sustainability Awareness after SDG-Themed Project-Based Writing

The first research question examined whether SDG-themed Project-Based Writing improved students' environmental sustainability awareness. The analysis was conducted by comparing students' sustainability awareness scores before and after the intervention using descriptive statistics and a paired-samples t-test. The sustainability awareness questionnaire consisted of 25 items measuring five dimensions: environmental sustainability knowledge, attitudes, sustainability practices, critical awareness and responsibility, and environmental engagement and communication. The instrument demonstrated high internal consistency, with Cronbach's alpha values of 0.856 before treatment and 0.944 after treatment, indicating excellent reliability. Table 1 presents the descriptive statistics of students' environmental sustainability awareness before and after participating in SDG-themed Project-Based Writing.

Table 1. Descriptive Statistics of Students' Environmental Sustainability Awareness

Measurement	N	Minimum	Maximum	Mean	SD
Pre-intervention sustainability awareness	42	80.00	115.00	96.10	8.01
Post-intervention sustainability awareness	42	88.00	124.00	105.83	9.34

The descriptive results indicate that students' sustainability awareness increased after participating in the SDG-themed Project-Based Writing intervention. Before the intervention, students obtained a mean score of 96.10 (SD = 8.01), whereas the post-intervention mean increased to 105.83 (SD = 9.34). The average improvement was 9.74 points, indicating a positive change in students' awareness after engaging in sustainability-oriented writing projects. Before conducting the paired-samples t-test, the normality assumption was examined using the Shapiro–Wilk test. The results indicated that both pretest and posttest sustainability awareness scores were normally distributed (pretest: $W = .971$, $p = .365$; posttest: $W = .973$, $p = .417$), allowing the use of parametric analysis.

Table 2. Paired-Samples t-Test of Environmental Sustainability Awareness

Variable	Mean Difference	t	df	Sig. (2-tailed)
Pretest–Posttest Sustainability Awareness	-9.74	-5.95	41	< .001

The paired-samples t-test revealed a statistically significant improvement in students' environmental sustainability awareness after the implementation of SDG-themed Project-Based Writing, $t(41) = -5.95$, $p < .001$. The negative mean difference reflects that posttest scores were higher than pretest scores. The 95% confidence interval ranged from -13.05 to -6.43 , confirming that the improvement was statistically significant. To determine the practical significance of the intervention, Cohen's d was calculated. The analysis produced an effect size of $|d| = 1.119$, indicating a large effect. This finding demonstrates that the improvement was not only statistically significant but also educationally meaningful.

Table 3. Dimension-Level Improvement of Environmental Sustainability Awareness

Dimension	Pretest Mean	Posttest Mean	Gain
Environmental Sustainability Knowledge	3.75	4.60	0.85
Environmental Sustainability Attitudes	4.23	4.57	0.34
Sustainability Practices	3.83	4.11	0.28
Critical Awareness and Responsibility	3.80	4.10	0.30
Environmental Engagement and Communication	3.60	3.78	0.17

Table 3 presents the dimension-level improvement of environmental sustainability awareness based on the comparison between pretest and posttest scores. Overall, all dimensions demonstrated positive improvements after the intervention, indicating that the learning experience contributed to strengthening participants' environmental sustainability awareness. The most substantial increase was observed in Environmental Sustainability Knowledge, which improved from a pretest mean of 3.75 to a posttest mean of 4.60, resulting in a gain score of 0.85. This finding suggests that the intervention was particularly effective in enhancing participants' conceptual understanding of environmental sustainability issues, including knowledge of ecological principles, environmental challenges, and sustainable solutions. The improvement in knowledge may reflect the effectiveness of the learning activities in providing meaningful information, contextual examples, and opportunities for participants to explore environmental concepts through inquiry, discussion, and reflection. Meanwhile, Environmental Sustainability Attitudes also showed a high level of improvement, increasing from 4.23 to 4.57 with a gain of 0.34. Although the initial attitude score was already relatively high, the posttest results indicate that participants further developed positive dispositions toward environmental protection, conservation, and sustainable behaviors.

The remaining dimensions also showed consistent positive changes, although with smaller gains. Sustainability Practices increased from 3.83 to 4.11 (gain = 0.28), indicating that participants demonstrated improved readiness and commitment to applying sustainability principles in daily activities. Similarly, Critical Awareness and Responsibility improved from 3.80 to 4.10 (gain = 0.30), suggesting enhanced awareness of environmental consequences and a stronger sense of personal responsibility for addressing sustainability challenges. The smallest improvement occurred in Environmental Engagement and Communication, which increased from 3.60 to 3.78 with a gain of 0.17. This relatively lower gain may indicate that developing active environmental participation, advocacy, and communication skills requires a longer period of practice and social engagement compared with knowledge acquisition. Nevertheless, the overall pattern demonstrates that the intervention successfully promoted multidimensional environmental sustainability awareness, progressing beyond cognitive understanding toward the development of attitudes, practices, responsibility, and engagement behaviors. These findings highlight the importance of sustainability-

oriented learning approaches that integrate knowledge development with authentic experiences and opportunities for environmental action.

Improvement of Students' Academic Writing Performance after SDG-Themed Project-Based Writing

The second research question investigated whether SDG-themed Project-Based Writing improved students' academic writing performance. Writing performance was assessed using an analytic rubric covering five dimensions: text organization, coherence and cohesion, language accuracy, academic resources, and argumentation quality.

Table 4. Descriptive Statistics of Students' Academic Writing Performance

Measurement	N	Minimum	Maximum	Mean	SD
Pretest Writing Performance	42	60.00	84.00	68.52	8.18
Posttest Writing Performance	42	66.00	92.00	79.40	5.22

Table 4 presents the descriptive statistics of students' academic writing performance before and after the implementation of the learning intervention. The results indicate that the pretest writing performance of the 42 students showed a mean score of 68.52 with a standard deviation (SD) of 8.18, with scores ranging from 60.00 to 84.00. The relatively larger standard deviation in the pretest results suggests that students' initial writing abilities were heterogeneous, with considerable variation in their academic writing skills. Some students demonstrated relatively strong writing competence, while others still experienced difficulties in organizing ideas, developing arguments, using appropriate academic language, and maintaining coherence and accuracy in written expression. This variation reflects the diverse levels of students' prior knowledge and writing experiences before participating in the intervention.

Following the intervention, the posttest results revealed a substantial improvement in students' academic writing performance. The mean score increased from 68.52 in the pretest to 79.40 in the posttest, representing an improvement of 10.88 points. In addition, the score range shifted upward, with the minimum score increasing from 60.00 to 66.00 and the maximum score increasing from 84.00 to 92.00. The reduction in standard deviation from 8.18 to 5.22 indicates that students' writing performances became more consistent after the intervention, suggesting that the learning process not only improved overall achievement but also reduced disparities among students. The findings imply that the instructional approach effectively supported students in developing academic writing competencies, particularly in aspects related to content development, organization, argumentation, and the use of academic conventions. Thus, the improvement in both mean achievement and score distribution demonstrates the positive contribution of the intervention toward enhancing students' academic writing performance.

The category-level analysis revealed that improvement was not distributed equally across writing components.

Table 8. Category-Level Improvement of Academic Writing Performance

Writing Component	Pretest Mean	Posttest Mean	Gain
Text Organization	3.83	4.20	0.37
Coherence and Cohesion	3.81	4.04	0.23
Language Accuracy	4.00	3.99	-0.01
Academic Resources	2.00	3.75	1.75
Quality of Argumentation	3.50	3.83	0.33

The greatest improvement occurred in academic resource use, increasing from 2.00 to 3.75 (gain = 1.75). Improvements were also found in text organization, argumentation

quality, and coherence/cohesion. However, language accuracy showed almost no change, decreasing slightly from 4.00 to 3.99. The results demonstrate that SDG-themed Project-Based Writing effectively improved both sustainability awareness and academic writing performance among EFL students. The intervention produced a statistically significant increase in sustainability awareness with a large effect size ($d = 1.119$) and significantly enhanced academic writing performance with a very large effect size ($d = 1.585$). The strongest improvements occurred in sustainability knowledge and academic source integration, suggesting that authentic SDG-based projects encouraged students to investigate real-world issues, evaluate information, and construct evidence-based academic texts.

These findings provide empirical support for integrating Education for Sustainable Development (ESD) into EFL academic writing courses by demonstrating that writing activities can simultaneously develop language competence, sustainability literacy, and higher-order thinking skills.

Discussion

The present study demonstrates that SDG-themed Project-Based Writing significantly enhanced both environmental sustainability awareness and academic writing performance among EFL students. These findings indicate that integrating sustainability-oriented content into academic writing instruction can transform writing activities from conventional language exercises into meaningful learning experiences involving inquiry, critical reflection, evidence evaluation, and social engagement. The results support the broader perspective of Education for Sustainable Development (ESD), which emphasizes that education should develop not only knowledge but also values, competencies, and capacities for addressing sustainability challenges (UNESCO, 2017; UNESCO, 2020).

The significant improvement in environmental sustainability awareness confirms that SDG-themed Project-Based Writing can function as an effective vehicle for sustainability education within EFL contexts. Students' sustainability awareness increased from a mean score of 96.10 before treatment to 105.83 after treatment, producing a significant improvement with a large effect size ($|d| = 1.119$). This finding confirms previous research showing that project-based learning provides opportunities for students to engage with authentic problems and develop deeper conceptual understanding through investigation and problem solving (Thomas, 2000; Bell, 2010; Kokotsaki et al., 2016). Similar findings have been reported in sustainability-oriented project learning, where SDG-integrated projects improved students' sustainability knowledge, attitudes, and environmental responsibility.

The strongest improvement was found in the dimension of environmental sustainability knowledge, which increased by 0.85 points, whereas environmental engagement and communication showed the smallest gain (0.17). This pattern suggests that project-based writing is particularly effective in developing cognitive aspects of sustainability awareness because students must search for information, evaluate academic sources, and construct arguments based on evidence. This finding aligns with Wiek et al. (2011) and Rieckmann (2018), who argue that sustainability education should develop systems thinking, critical thinking, and knowledge-based decision-making. However, the smaller improvement in behavioral and engagement dimensions suggests that awareness development does not automatically translate into sustainable action. Previous studies have demonstrated that environmental knowledge is only one factor influencing pro-environmental behavior, which is also shaped by social context, motivation, institutional support, and opportunities for practice (Stern, 2000; Kollmuss

& Agyeman, 2002). Therefore, while SDG-themed writing projects effectively strengthen students' understanding of sustainability issues, longer-term experiential activities may be required to produce stronger behavioral transformation.

The findings also extend previous EFL research by demonstrating that sustainability themes can enhance academic writing development. Students' writing performance improved from a mean score of 68.52 to 79.40, with a very large effect size ($|d| = 1.585$). This finding confirms research emphasizing that writing development is strengthened when students engage in authentic communication purposes rather than isolated grammar exercises (Hyland, 2003; Ferris & Hedgcock, 2014). Through SDG-themed projects, students were required to investigate environmental issues, synthesize information, construct arguments, and communicate solutions in academic forms. These activities correspond with the principles of Project-Based Learning, which emphasize sustained inquiry, collaboration, revision, and production of meaningful outcomes (Thomas, 2000; Stoller, 2006).

The category-level writing analysis provides further evidence regarding how the intervention influenced students' writing development. The largest improvement occurred in academic resource use, increasing from 2.00 to 3.75 (gain = 1.75). Improvements were also observed in text organization, coherence and cohesion, and argumentation quality. This finding is consistent with the academic literacies perspective proposed by Lea and Street (1998), which views academic writing as a process of knowledge construction involving engagement with disciplinary sources, argument development, and rhetorical decision-making. Students participating in SDG projects were required to locate credible information, compare perspectives, and justify claims using evidence, which likely contributed to stronger academic source integration.

The improvement in argumentation quality further supports previous studies highlighting the relationship between inquiry-based learning and critical writing development. Writing about sustainability issues requires students to analyze complex problems, evaluate alternative viewpoints, and propose solutions. This process aligns with Wingate's (2012) argument that academic writing instruction should explicitly develop students' ability to construct arguments rather than simply focus on textual accuracy. The current findings therefore extend previous research by showing that sustainability themes provide meaningful contexts for practicing academic reasoning.

However, language accuracy showed almost no improvement, decreasing slightly from 4.00 to 3.99. This finding differs from studies that associate writing interventions with improvements across multiple linguistic dimensions. One possible explanation is that SDG-themed Project-Based Writing primarily emphasized higher-order writing processes, including researching, organizing ideas, and constructing arguments, rather than explicit grammatical instruction. Flower and Hayes' (1981) Cognitive Process Theory of Writing explains that writers have limited cognitive resources that must be distributed among planning, translating ideas into text, and reviewing. When students engage in cognitively demanding tasks, attention may prioritize content development and rhetorical effectiveness over grammatical monitoring. This suggests that project-based writing should be complemented with targeted language-focused feedback to achieve balanced improvement.

The present findings also contribute to the growing literature on integrating SDGs into EFL education. Previous studies have shown that SDG-oriented projects can promote communication skills, critical thinking, and sustainability awareness among language learners. The current study extends this body of research by providing quantitative evidence that SDG-themed Project-Based Writing can simultaneously improve sustainability awareness and measurable academic writing performance. Unlike

approaches that treat sustainability as additional classroom content, the present model integrates sustainability issues directly into the writing process, making language learning socially meaningful.

Despite these contributions, the findings should be interpreted considering methodological limitations. The study employed a one-group pretest–posttest design without a control group, meaning that improvements cannot be attributed exclusively to the intervention. Additionally, the sample was limited to one institutional context. Future research should employ quasi-experimental or randomized designs involving multiple institutions to strengthen causal conclusions. Longitudinal studies are also needed to determine whether sustainability awareness and writing improvements are maintained over time. The findings provide strong evidence that SDG-themed Project-Based Writing represents a promising pedagogical approach for EFL higher education. It bridges language development with sustainability education by enabling students to use English as a tool for investigating global issues, constructing evidence-based arguments, and developing responsible perspectives toward sustainable development.

CONCLUSION

This study concludes that SDG-themed Project-Based Writing effectively enhanced EFL students' environmental sustainability awareness and academic writing performance. The intervention produced significant improvements in sustainability awareness, with a large practical effect, indicating that students developed stronger understanding, attitudes, responsibility, and engagement toward sustainability issues. Among the sustainability dimensions, knowledge showed the greatest improvement, suggesting that authentic inquiry, academic source exploration, and evidence-based writing activities successfully strengthened students' conceptual understanding of environmental challenges. These findings demonstrate that integrating SDGs into academic writing courses provides meaningful opportunities to connect language learning with global sustainability issues and supports the objectives of Education for Sustainable Development.

The study also confirms that SDG-themed Project-Based Writing significantly improves higher-order academic writing abilities. Students demonstrated substantial gains in academic resource use, organization, argumentation, and coherence, although language accuracy remained relatively unchanged. This indicates that project-based writing is particularly effective in developing cognitive and rhetorical dimensions of writing by encouraging students to investigate problems, synthesize information, and construct evidence-supported arguments. Future implementations should combine project-based sustainability writing with explicit language-focused instruction to strengthen grammatical accuracy. Despite limitations related to research design and sample scope, the findings provide valuable evidence that SDG-oriented Project-Based Writing represents a sustainable pedagogical approach for EFL higher education by simultaneously promoting language competence, critical thinking, and sustainability literacy.

RECOMMENDATION

Future studies employing quasi-experimental or true experimental designs with comparison groups are recommended to further validate and generalize these findings. Such designs would allow researchers to establish stronger causal inferences by systematically controlling for confounding variables that may have influenced the outcomes observed in the present study. The inclusion of control or comparison groups, whether through randomized controlled trials or matched-group designs, would enable more rigorous testing of the intervention's or variable's effectiveness relative to standard

practice or no intervention at all. Additionally, future research should consider larger and more diverse sample sizes drawn from multiple settings or populations to enhance the external validity and generalizability of the results beyond the specific context examined in this study. Longitudinal follow-up assessments would also be valuable in determining whether the observed effects are sustained over time or diminish after the initial intervention period. By addressing these methodological considerations, subsequent studies can build upon the preliminary evidence presented here, offering more robust and generalizable conclusions that can better inform theory, policy, and practice in this field.

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Declaration of Using AI Tools

During the preparation of this manuscript, artificial intelligence (AI) tools were used as supporting instruments for language editing, improving writing clarity, and assisting with the organization of academic expressions. AI tools were not used to generate research data, conduct statistical analyses, manipulate findings, or replace the authors' scholarly interpretation. All research procedures, data collection, analysis decisions, interpretations, and conclusions remain the sole responsibility of the authors. The authors carefully reviewed and verified all AI-assisted outputs to ensure accuracy, academic integrity, and consistency with the research objectives. The use of AI tools followed responsible research and publication practices.

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