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Evaluating the impact of an eco-friendly education program on preschool children's sustainability behaviors and environmental awareness

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ABSTRACT

This study examined the effectiveness of an Eco-Friendly Education Program (EDEP) on the sustainability behaviors and environmental awareness of preschool children aged 60–72 months. Employing a quasi-experimental pretest–posttest control group design, the research was conducted in a public preschool in Sakarya, Türkiye, with an experimental group (n = 20) and a control group (n = 24). The EDEP comprised 16 integrated activity sets encompassing 49 individual activities organized around six thematic areas—plant life cycles, recycling, pollution prevention, energy conservation, climate change awareness, and sustainable nutrition—delivered twice weekly over eight weeks with a cumulative contact time of approximately 12 hours. The control group followed the standard Ministry of National Education (MoNE) preschool curriculum without supplementary environmental content. Data were collected using two validated instruments: the Sustainable Behaviour Assessment Scale (SBAS; Özkan et al., 2019; 20 items, 5-point Likert, two sub-dimensions) and the Environmental Awareness and Attitude Scale for Preschool Children (EAASPC; Büyüktaşkapu Soydan & Öztürk Samur, 2017; 26 items, two sub-dimensions). As Shapiro–Wilk tests indicated non-normal distributions, Mann–Whitney U and Wilcoxon signed-rank tests were employed. Results revealed statistically significant improvements in the experimental group across all sub-dimensions of both scales (p < .001), with all 20 children demonstrating positive change on multiple measures. The control group showed mixed results: significant gains on some sub-dimensions but an unexpected decline in environmental awareness scores. Post-test between-group comparisons confirmed that the experimental group significantly outperformed the control group on all sub-dimensions (p < .001), with large effect sizes (r = .75–.85). These findings provide robust evidence that structured, multi-component environmental education during early childhood can meaningfully enhance both sustainability behaviors and environmental awareness, supporting the broader integration of such programs into preschool curricula.

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Introduction

The environmental challenges confronting humanity in the twenty-first century—climate change, biodiversity loss, water scarcity, and widespread pollution—are not merely scientific or policy concerns; they are fundamentally educational ones. The Intergovernmental Panel on Climate Change (IPCC, 2021) has unequivocally established that anthropogenic activity drives the most pressing environmental crises of our time, and the United Nations' Sustainable Development Goals (SDGs) explicitly recognize education as a

primary vehicle for catalyzing the behavioral and attitudinal shifts necessary to address these challenges (United Nations, 2015). Within this global context, environmental education has emerged as a critical mechanism for cultivating the knowledge, skills, values, and dispositions that enable individuals to live sustainably.

Among the various stages of the educational continuum, early childhood occupies a uniquely strategic position. Research in developmental psychology consistently demonstrates that the period between birth and age six represents a critical window for the formation of attitudes, habits, and values that persist into adulthood (Hedefalk et al., 2015). Children's cognitive, affective, and behavioral patterns are remarkably malleable during this stage, and the environmental dispositions formed in early childhood exert a disproportionate influence on lifelong behavior (Chawla & Derr, 2012). Wilson (1996) was among the first to argue that direct, sensory-rich experiences with nature during early childhood are essential for developing genuine environmental sensitivity—a claim that has since been supported by a substantial body of empirical evidence. Gülay Ogelman and Güngör (2015), in their comprehensive review of Turkish preschool environmental education research from 2000 to 2014, confirmed that environmental education during this period lays the foundation for enduring environmentally responsible behaviors, although they noted significant gaps in the scope and rigor of existing studies.

The theoretical case for early environmental education is further strengthened by social learning theory (Bandura, 1977), which posits that children acquire behaviors through observation, imitation, and reinforcement. When educators and caregivers model environmentally responsible behaviors—sorting waste, conserving water, caring for plants—children internalize these practices as normative. Constructivist frameworks complement this perspective by emphasizing that lasting learning occurs when children actively engage with their environment through hands-on exploration, experimentation, and reflection (Davis & Elliott, 2009). Together, these theoretical perspectives suggest that environmental education programs for young children should be experiential, multi-modal, and embedded in children's daily routines—principles that guided the development of the Eco-Friendly Education Program (EDEP) evaluated in this study.

Empirical evidence broadly supports the effectiveness of environmental education interventions. A meta-analysis by Zhang and Chen (2020) synthesized findings from multiple studies and confirmed a positive overall effect of environmental education on children's sustainable behaviors. At the individual study level, Ernst and Monroe (2004) demonstrated that environment-based education enhanced critical thinking, while Iwasaki (2022) showed that a Japanese preschool program incorporating visual cues effectively improved water-saving behaviors. In the Turkish context specifically, several intervention studies have yielded promising results: Cevher-Kalburan and Alisinanoğlu (2010) found significant improvements in environmental attitudes following a structured program; Ahi (2015) demonstrated positive effects on children's mental models of the environment; Güzelyurt and Özkan (2017) reported increased environmental awareness through play-based approaches; and Çakır and Kanak (2023) documented environmental literacy gains in a recent trial study. However, the picture is not uniformly positive: Yılmaz et al. (2020) found that a shorter four-week program in Mersin produced no significant changes in environmental awareness, raising important questions about the minimum duration and intensity required for meaningful impact.

Despite this growing body of evidence, a critical gap persists. Most existing studies in Türkiye have assessed either sustainability behaviors or environmental awareness/attitudes in isolation, rarely both simultaneously in a single controlled design. Furthermore, few have provided the level of methodological detail—regarding instrument psychometrics, program structure, implementation fidelity, and statistical reporting—necessary for replication and cumulative scientific progress (Engdahl, 2015; Kahriman-Öztürk et al., 2012). The present study addresses these gaps by evaluating a researcher-developed, expert-reviewed, eight-week EDEP using two validated instruments in a quasi-experimental design, with comprehensive reporting of both sustainability behaviors and environmental awareness/attitudes.

Problem definition

The rationale for this study rests on three interconnected observations. First, Hedefalk et al.'s (2015) systematic review of education for sustainable development in early childhood identified that the majority of existing research has concentrated on school-aged children and adolescents, with preschool-aged populations remaining underrepresented. This is particularly problematic given the developmental significance of the early childhood period for habit and value formation.

Second, within the Turkish educational context, there exists a disjunction between policy aspirations and research evidence. Although the MoNE Preschool Education Program (MoNE, 2013) includes outcomes related to environmental awareness, the curriculum does not prescribe a dedicated, structured environmental education component. The few intervention studies that have been conducted have

typically assessed only one dimension of environmental competence—either attitudes (Cevher-Kalburan & Alisinanoğlu, 2010) or specific behaviors (Öztap & Bartan, 2019)—making it difficult to draw comprehensive conclusions about program effectiveness.

Third, the question of program duration remains unresolved. Yılmaz et al.'s (2020) finding that a four-week program produced no measurable change in environmental awareness suggests that brief interventions may be insufficient. The present study's eight-week, multi-component design was specifically developed to test whether a more intensive and sustained intervention can produce meaningful improvements across both behavioral and attitudinal domains.

Accordingly, this study addresses the following overarching research question: What is the impact of a structured, eight-week EDEP on preschool children's (a) sustainability behaviors and (b) environmental awareness and attitudes?

Objectives and hypotheses

The primary aim of this study is to evaluate the EDEP's impact on two interrelated but distinct outcome domains: sustainability behaviors and environmental awareness/attitudes. Three sub-objectives guide the analysis: (1) to compare pre-test and post-test scores within each group on both outcome measures; (2) to compare post-test scores between the experimental and control groups; and (3) to examine the consistency and magnitude of effects across sub-dimensions of both instruments.

Baseline equivalence between groups was assessed as a preliminary analysis rather than a substantive hypothesis. The following directional hypotheses were tested at $\alpha = .05$:

H_1: The experimental group will demonstrate a statistically significant increase in SBAS scores (both Awareness and Consciousness sub-dimensions) from pre-test to post-test.

H_2: The experimental group will demonstrate a statistically significant increase in EAASPC scores (both Environmental Attitude and Environmental Awareness sub-dimensions) from pre-test to post-test.

H_3: Post-test SBAS scores of the experimental group will be significantly higher than those of the control group on both sub-dimensions.

H_4: Post-test EAASPC scores of the experimental group will be significantly higher than those of the control group on both sub-dimensions.

Conceptual framework

Defining key constructs: Sustainability behaviors and environmental awareness

A rigorous examination of the EDEP's effectiveness requires clear operational definitions of the constructs under investigation. In this study, sustainability behaviors are conceptualized as observable, environmentally responsible actions that children perform in their interactions with the natural and built environment. Following Özkan et al. (2019), this construct encompasses three interrelated dimensions: a cognitive dimension (understanding why specific behaviors, such as recycling or water conservation, are important), an affective dimension (caring about natural ecosystems and expressing concern for environmental degradation), and a behavioral dimension (actively engaging in practices such as waste separation, energy conservation, and nature protection). The SBAS operationalizes this construct through two sub-dimensions: Awareness, which captures children's recognition of environmental issues and their consequences (11 items), and Consciousness, which assesses active, deliberate engagement in sustainable practices (9 items).

Environmental awareness and attitudes, the second outcome domain, refers to children's knowledge about environmental phenomena and their affective orientation toward the natural world (Büyüktaşkapu Soydan & Öztürk Samur, 2017). The EAASPC captures this through two sub-dimensions: Environmental Attitude (15 items assessing predisposition to act positively toward the environment) and Environmental Awareness (11 items assessing factual knowledge and recognition of environmental phenomena). These two constructs—behaviors and awareness/attitudes—are theoretically interrelated but empirically distinct. Hungerford and Volk (1990) proposed that environmental knowledge and awareness are necessary but not sufficient precursors to behavioral change; the transition from awareness to action requires additional motivational and situational factors, including self-efficacy, locus of control, and a sense of personal responsibility. This theoretical perspective informed the decision to assess both constructs simultaneously, providing a more comprehensive evaluation of the EDEP's effectiveness than would be possible by examining either domain in isolation (Ardoin et al., 2018).

Theoretical foundations

The EDEP's design is grounded in two complementary theoretical frameworks that together provide a robust rationale for the program's pedagogical approach. Bandura's (1977) social learning theory posits that children acquire new behaviors primarily through observation, imitation, and reinforcement. Applied to environmental education, this theory suggests that when educators consistently model environmentally responsible behaviors—demonstrating recycling procedures, expressing care for living things, narrating their reasoning about resource conservation—children internalize these practices as social norms. The EDEP was designed to maximize such modeling opportunities: the researcher conducted all sessions personally, demonstrating target behaviors within each activity and providing positive reinforcement when children engaged in pro-environmental actions.

Constructivist learning principles, drawing on the work of Piaget and Vygotsky, provide the second theoretical pillar. From this perspective, meaningful learning occurs not through passive reception of information but through active engagement with the physical and social environment (Davis & Elliott, 2009). The EDEP's design reflects this principle in its emphasis on experiential, multi-sensory activities: children planted seeds and observed growth cycles, visited recycling facilities, conducted simple science experiments on water pollution, and created art from recycled materials. These direct, hands-on experiences were intended to facilitate the construction of robust environmental understanding that would be more durable and more readily transferable to everyday behavior than knowledge acquired through didactic instruction alone.

Evidence base: International and Turkish perspectives

International research provides consistent, though not uniform, support for the effectiveness of environmental education in early childhood. Zhang and Chen's (2020) meta-analysis documented a positive overall effect across diverse program types and cultural contexts. Ernst and Monroe (2004) found that environment-based education enhanced not only environmental knowledge but also critical thinking disposition—a finding that suggests environmental education may yield cognitive benefits beyond its immediate content domain. Iwasaki (2022) demonstrated that even relatively simple interventions, such as placing visual prompts near water taps, could modify preschoolers' conservation behaviors when combined with instructional content about water and energy resources.

Within Türkiye, the evidence base is growing but remains fragmented. Cevher-Kalburan and Alisinanoğlu (2010) found that a structured environmental education program significantly improved both preschool children's and their parents' environmental attitudes. Ahi (2015) demonstrated that an integrated program influenced children's mental models of the 'environment' concept, shifting their understanding from narrow, human-centered conceptions to more ecologically inclusive ones. Güzelyurt and Özkan (2017) reported that play-based environmental education activities increased children's environmental awareness. Öztap and Bartan (2019) found that art activities using recycled materials improved recycling awareness among preschoolers. However, Yılmaz et al. (2020) found no significant effect of a four-week program on children's environmental attitudes in Mersin—a null finding that underscores the importance of program duration and intensity as potential moderating variables. The present study's eight-week design, with twice-weekly sessions and diverse activity types, was developed specifically to address this concern.

Method

Research design

This study employed a quasi-experimental pretest–posttest control group design, which is widely regarded as the most rigorous design available when random assignment of individuals to conditions is not feasible (Shadish et al., 2002). The research was conducted during the 2023–2024 academic year in a public preschool affiliated with a primary school in Serdivan, Sakarya, Türkiye. Two pre-existing intact classrooms within the same school were designated as the experimental and control groups, respectively. Random assignment of individual children to groups was not possible due to the school's organizational structure, a common constraint in educational field research (Campbell & Stanley, 1963). The study therefore employed convenience sampling, with groups drawn from available classrooms. To partially mitigate the threat to internal validity posed by non-random assignment, baseline equivalence between groups was assessed on all outcome measures prior to the intervention.

Ethical considerations

Ethical approval for this study was obtained from the Marmara University Ethics Committee. Given that participants were preschool-aged children, particular attention was paid to ethical safeguards. Written

informed consent was obtained from all parents and legal guardians prior to data collection; each family received a detailed information sheet explaining the study's purpose, procedures, voluntary nature, and confidentiality protections. Children were given age-appropriate verbal explanations of the activities and were assured that they could choose not to participate at any time without consequence. Throughout the study, the researcher remained attentive to signs of distress or disengagement and ensured that all activities were experienced as enjoyable rather than evaluative. All data were anonymized using coded identifiers, stored on encrypted institutional servers with access restricted to the research team, and will be retained for five years in compliance with institutional data management policies.

Participants

A total of 44 children aged 60–72 months participated in the study: 20 in the experimental group (10 girls, 10 boys) and 24 in the control group (11 girls, 13 boys). All children were enrolled in the same public preschool and attended school regularly throughout the study period. Table 1 presents comprehensive demographic characteristics of both groups, including gender distribution, sibling count, preschool attendance duration, parental education levels, parental age ranges, and self-reported socioeconomic status. The majority of families in both groups reported middle socioeconomic status, and the demographic profiles of the two groups were broadly comparable.

Table 1. *Demographic Characteristics of Experimental and Control Groups*

Characteristic		Experimental (f)	Control (f)	Total (f)
Gender	Female	10	11	21
	Male	10	13	23
Siblings	Only child	4	6	10
	One sibling	9	11	20
	Two or more siblings	7	7	14
Preschool attendance	1 year	15	13	28
	2 years	4	8	12
	3 years	1	3	4
Mother education	Primary school	1	3	4
	Secondary school	2	6	8
	High school	9	11	20
	Associate degree	8	3	11
	Bachelor's degree	0	1	1
Father education	Primary school	1	1	2
	Secondary school	0	4	4
	High school	8	11	19
	Associate degree	11	6	17
	Bachelor's degree	0	2	2
SES (self-reported)	Low	3	1	4
	Middle	17	23	40

Note. SES = socioeconomic status. The Personal Information Form was completed by parents/guardians.

Data collection tools

Sustainable Behaviour Assessment Scale (SBAS)

The SBAS, developed by Özkan et al. (2019), is a teacher-report instrument designed to assess 60–72-month-old children's environment-oriented sustainability behaviors. The scale consists of 20 items rated on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*), with higher scores indicating more developed sustainability behaviors. The scale comprises two sub-dimensions: Awareness (11 items; e.g., recognizes the recycling symbol, understands the importance of air for human life, knows the causes of water pollution) and Consciousness (9 items; e.g., actively separates waste, conserves water, protects plants). The original validation study was conducted with 426 preschool children across Istanbul (Kadıköy and Beşiktaş districts), Kütahya, and Yalova, yielding Cronbach's α coefficients of .92 for Awareness, .94 for Consciousness, and .92 for the total scale—values indicating excellent internal consistency.

In the present study, the SBAS was completed by classroom teachers through structured observation of each child's behaviors, both before and after the eight-week intervention period. Each teacher independently rated the children in their classroom. An important methodological consideration is that the observing teachers were not blind to group assignment: the experimental group teacher was aware that the EDEP was

being conducted, and the control group teacher was aware that their classroom served as a comparison. This introduces the possibility of observer expectancy bias, which is acknowledged and discussed as a limitation of the study.

Environmental Awareness and Attitude Scale for Preschool Children (EAASPC)

The EAASPC, developed by Büyüktaşkapu Soydan and Öztürk Samur (2017), is an individually administered instrument designed to assess preschool children's environmental attitudes and awareness. The scale comprises 26 items organized into two sub-dimensions: Environmental Attitude (15 items) and Environmental Awareness (11 items). Both positively and negatively worded items are included, and each item is accompanied by simple, child-friendly illustrations to facilitate comprehension.

Administration follows a standardized protocol. For the Environmental Attitude subscale, children were shown pairs of contrasting pictures depicting environmentally positive and negative behaviors and asked to point to the picture that was 'right for them.' For the Environmental Awareness subscale, children were given three color-coded response cards—green (true/correct), red (false/incorrect), and yellow (unsure/don't know)—and asked to respond to illustrated questions about environmental phenomena. Practice items were used to ensure comprehension of the response format before proceeding to test items. Typical administration time was approximately 15 minutes per child. All EAASPC administrations were conducted individually by the researcher in both groups, before and after the intervention period.

The original validation study reported a Spearman–Brown split-half reliability coefficient of .60 and a Cronbach's α of .67. Item discrimination indices ranged from .34 to .47 for the Environmental Attitude subscale and .32 to .40 for the Environmental Awareness subscale, with a mean discrimination index of .38. While these reliability values are modest by conventional standards, they are considered acceptable for instruments designed for very young children using binary or three-option response formats (Nunnally & Bernstein, 1994). Nevertheless, the relatively low reliability of the EAASPC—particularly compared to the SBAS—introduces greater measurement error, which should be considered when interpreting the environmental awareness/attitude findings. This limitation is discussed in detail in the Discussion section.

Eco-Friendly Education Program (EDEP)

The EDEP was developed by the researcher based on the learning outcomes and developmental indicators specified in the MoNE Preschool Education Program (MoNE, 2013). The program was designed to be comprehensive, experiential, and developmentally appropriate, incorporating multiple pedagogical modalities: Turkish language activities (storytelling, discussion, vocabulary building), art activities (creating with recycled materials, nature-themed crafts), drama (role-playing environmental scenarios), music (learning songs about nature and conservation), movement activities (nature walks, physical games with environmental themes), free play (exploration stations with environmental materials), science activities (planting seeds, observing water pollution effects, sorting materials), mathematics (counting, classifying, and graphing environmental data), and field trips (visits to local parks, recycling centers, and nature areas).

Prior to implementation, the program content was reviewed by three domain experts: two faculty members specializing in early childhood education and one specializing in environmental education. Expert feedback led to revisions in activity sequencing, language complexity, and the balance between structured and exploratory activities. The finalized program comprised 16 integrated activity sets encompassing a total of 49 individual activities, organized around six thematic areas: (1) understanding plant life cycles and growing plants; (2) recycling and environmental restoration skills; (3) preventing environmental pollution; (4) understanding and practicing energy conservation; (5) climate change and global warming awareness; and (6) seasonal, healthy, and sustainable nutrition awareness. Table 2 provides a detailed breakdown of activities by theme and type.

Activities were delivered twice weekly over eight weeks, with each session lasting approximately 45 minutes, yielding a cumulative contact time of approximately 12 hours. All sessions were conducted in the school setting by the researcher, ensuring consistency of delivery. The researcher maintained a session-by-session implementation checklist documenting completed activities, deviations from the plan, children's engagement levels, and notable observations. All 20 children in the experimental group participated in all sessions. The classroom teacher in the experimental group continued to deliver the standard MoNE curriculum alongside the EDEP activities. The control group received only the standard MoNE preschool curriculum throughout the eight-week period, with no supplementary environmental education content.

Table 2. *EDEP Activities by Theme and Activity Type*

Theme	Turkish	Art	Drama	Music	Movement	Play	Science	Math	Field trips
Plant life cycles	3	1	1	1	–	–	3	–	–
Recycling & restoration	4	2	–	1	–	5	3	1	1
Pollution prevention	4	3	1	–	–	4	2	1	1
Energy conservation	3	1	1	–	–	2	1	–	–
Climate change awareness	1	1	–	–	1	–	1	–	–
Sustainable nutrition	1	1	–	–	–	1	–	–	2

Note. Turkish = Turkish language activities. All activities were delivered by the researcher.

Data analysis

All statistical analyses were performed using SPSS version 26.0. Given the small sample sizes (n = 20 and n = 24), the ordinal nature of the Likert-scale data, and the results of normality assessments indicating that score distributions did not satisfy the normality assumption, non-parametric tests were employed throughout the study. Between-group comparisons (experimental vs. control) were conducted using the Mann–Whitney U test, while within-group pre–post comparisons were conducted using the Wilcoxon signed-rank test.

To provide information about the practical significance of observed effects beyond statistical significance, effect sizes were calculated as $r = |Z| / \sqrt{N}$, where N represents the total number of observations involved in the comparison (Fritz et al., 2012). Following Cohen's (1988) widely adopted benchmarks, r values of approximately .10, .30, and .50 were interpreted as indicating small, medium, and large effects, respectively. The significance level was set at $\alpha = .05$ for all analyses.

Findings

The results are organized in four sections: baseline equivalence, within-group pre–post changes, between-group post-test comparisons, and a synthesis of findings across both scales.

Baseline equivalence

Prior to the intervention, Mann–Whitney U tests were conducted to verify that the experimental and control groups were comparable on all outcome measures. As presented in Table 3, no statistically significant differences were found between the groups on either SBAS sub-dimension (Awareness: $U = 192.000$, $Z = -1.135$, $p = .256$; Consciousness: $U = 185.500$, $Z = -1.294$, $p = .196$). Similarly, Table 4 shows that no significant differences were found on either EAASPC sub-dimension (Environmental Attitude: $p = .353$; Environmental Awareness: $p = .356$). These results confirm that the two groups were equivalent at baseline on all measured variables, strengthening the interpretability of subsequent between-group comparisons.

Table 3. *Mann–Whitney U Test Results for SBAS Pre-Test Scores*

Sub-dimension	Group	n	Mean rank	Sum of ranks	U	Z	p
Awareness	Experimental	20	24.90	498.00	192.000	−1.135	.256
	Control	24	20.50	492.00			
Consciousness	Experimental	20	19.78	395.50	185.500	−1.294	.196
	Control	24	24.77	594.50			

Note. p > .05 for both sub-dimensions.

Table 4. *Mann–Whitney U Test Results for EAASPC Pre-Test Scores*

Sub-dimension	Group	n	Mean rank	Sum of ranks	U	Z	p
Env. attitude	Experimental	20	24.45	489.00	201.000	−0.929	.353
	Control	24	20.88	501.00			
Env. awareness	Experimental	20	24.43	488.50	201.500	−0.923	.356
	Control	24	20.90	501.50			

Note. Env. = environmental. p > .05 for both sub-dimensions.

Within-group changes: Experimental group

Wilcoxon signed-rank tests revealed that the EDEP produced statistically significant and uniformly positive changes in the experimental group's sustainability behaviors (Table 5). On both the Awareness and Consciousness sub-dimensions, all 20 children demonstrated improved post-test scores relative to their pre-test scores—a striking finding with no negative ranks or ties. The effect sizes were large (r = .88 for both sub-dimensions), substantially exceeding Cohen's (1988) threshold of .50 for a large effect. These results provide strong support for H_1.

Table 5. *Wilcoxon Signed-Rank Test: Experimental Group, SBAS Pre–Post Comparison*

Sub-dimension	Post–pre	n	Mean rank	Sum of ranks	Z	p	r
Awareness	Negative	0	.00	.00	−3.923	< .001	.88
	Positive	20	10.50	210.00			
	Ties	0					
Consciousness	Negative	0	.00	.00	−3.924	< .001	.88
	Positive	20	10.50	210.00			
	Ties	0					

Note. r = |Z| / √N.

The experimental group also showed statistically significant improvements on both EAASPC sub-dimensions (Table 6), supporting H_2. On the Environmental Attitude subscale, all 20 children showed positive change (r = .88), mirroring the pattern observed on the SBAS. The Environmental Awareness subscale also showed significant improvement (Z = −2.903, p = .004, r = .65), though the effect was somewhat smaller and not universal: 17 children improved while 3 showed slight decreases. This pattern—a slightly weaker and less uniform effect on environmental awareness compared to environmental attitude—is consistent with the theoretical expectation that attitudinal change may precede and be more readily achieved than knowledge-based change (Hungerford & Volk, 1990), and may also reflect the EAASPC's more modest reliability on this subscale.

Table 6. *Wilcoxon Signed-Rank Test: Experimental Group, EAASPC Pre–Post Comparison*

Sub-dimension	Post–pre	n	Mean rank	Sum of ranks	Z	p	r
Env. attitude	Negative	0	.00	.00	−3.930	< .001	.88
	Positive	20	10.50	210.00			
	Ties	0					
Env. awareness	Negative	3	9.17	27.50	−2.903	.004	.65
	Positive	17	10.74	182.50			
	Ties	0					

Note. r = |Z| / √N. Env. = environmental.

Within-group Changes: Control group

The control group's results present a more complex and, in some respects, unexpected picture. On the SBAS (Table 7), both sub-dimensions showed statistically significant pre-to-post gains, contrary to the original hypothesis that the control group would remain stable. On Awareness, 18 children improved, 5 declined, and 1 remained unchanged (Z = −2.815, p = .005, r = .41). On Consciousness, 18 improved, 3 declined, and 3 remained unchanged (Z = −3.712, p < .001, r = .54). Critically, however, these effect sizes were medium rather than large, substantially smaller than the experimental group's effects. This suggests that while the standard MoNE curriculum, developmental maturation, or test-retest sensitization may contribute to some growth in sustainability-related behaviors over an eight-week period, the EDEP produces markedly greater gains.

Table 7. *Wilcoxon Signed-Rank Test: Control Group, SBAS Pre–Post Comparison*

Sub-dimension	Post–pre	n	Mean rank	Sum of ranks	Z	p	r
Awareness	Negative	5	9.10	45.50	−2.815	.005	.41
	Positive	18	12.81	230.50			
	Ties	1					
Consciousness	Negative	3	3.00	9.00	−3.712	< .001	.54
	Positive	18	12.33	222.00			
	Ties	3					

Note. r = |Z| / √N.

The EAASPC results for the control group were notably mixed (Table 8). The Environmental Attitude subscale showed a significant improvement favoring the post-test ($Z = -3.485$, $p < .001$, $r = .50$), with 20 children showing gains and 4 showing declines. However, a strikingly contrasting pattern emerged on the Environmental Awareness subscale: a statistically significant change in favor of the pre-test was observed ($Z = -2.530$, $p = .011$, $r = .37$), indicating that 16 children's awareness scores actually declined from pre-test to post-test, while only 5 improved and 3 remained stable. This unexpected decline in environmental awareness among children who did not receive targeted environmental content is one of the most noteworthy findings of this study and is examined in detail in the Discussion.

Table 8. *Wilcoxon Signed-Rank Test: Control Group, EAASPC Pre–Post Comparison*

Sub-dimension	Post–pre	n	Mean rank	Sum of ranks	Z	p	r
Env. attitude	Negative	4	7.13	28.50	−3.485	< .001	.50
	Positive	20	13.58	271.50			
	Ties	0					
Env. awareness	Negative	16	11.72	187.50	−2.530	.011	.37
	Positive	5	8.70	43.50			
	Ties	3					

Note. r = |Z| / √N. Environmental awareness change favored pre-test scores (i.e., scores declined).

Between-Group Post-Test Comparisons

The most critical test of the EDEP's effectiveness is the comparison of post-test scores between the experimental and control groups. As presented in Table 9, the experimental group scored significantly higher than the control group on both SBAS sub-dimensions, with effect sizes firmly in the large range (Awareness: $U = .000$, $Z = -5.665$, $p < .001$, $r = .85$; Consciousness: $U = 29.500$, $Z = -4.982$, $p < .001$, $r = .75$). These results provide robust support for H_3.

Table 9. *Mann–Whitney U Test Results for SBAS Post-Test Scores*

Sub-dimension	Group	n	Mean rank	Sum of ranks	U	Z	p	r
Awareness	Experimental	20	34.50	690.00	.000	−5.665	< .001	.85
	Control	24	12.50	300.00				
Consciousness	Experimental	20	33.03	660.50	29.500	−4.982	< .001	.75
	Control	24	13.73	329.50				

Note. r = |Z| / √N.

The pattern was replicated on the EAASPC (Table 10). The experimental group significantly outperformed the control group on both sub-dimensions, again with large effect sizes (Environmental Attitude: $r = .80$; Environmental Awareness: $r = .79$). H_4 was supported. The consistency of large between-group effects across all four sub-dimensions of two different instruments provides convergent evidence for the EDEP's effectiveness.

Table 10. *Mann–Whitney U Test Results for EAASPC Post-Test Scores*

Sub-dimension	Group	n	Mean rank	Sum of ranks	U	Z	p	r
Env. attitude	Experimental	20	33.70	674.00	16.000	−5.334	< .001	.80
	Control	24	13.17	316.00				
Env. awareness	Experimental	20	33.50	670.00	20.000	−5.230	< .001	.79
	Control	24	13.33	320.00				

Note. r = |Z| / √N. Env. = environmental.

Discussion

The present study set out to evaluate whether a structured, multi-component Eco-Friendly Education Program could produce measurable improvements in both sustainability behaviors and environmental awareness/attitudes among preschool children in Türkiye. The results provide a clear and consistent affirmative answer: all four hypotheses were supported, and the experimental group demonstrated statistically significant and practically large improvements across all sub-dimensions of both the SBAS and the EAASPC. The between-group effect sizes ($r = .75$–$.85$) are notable not only for their statistical magnitude but also for their consistency across two different instruments measuring conceptually distinct but related constructs. This convergence of evidence substantially strengthens the conclusion that the

EDEP's effects are genuine and not attributable to measurement artifacts or the peculiarities of a single instrument.

Consistency With International and Turkish Literature

The present findings align with and extend the broader evidence base supporting early childhood environmental education. The large effect sizes observed here are at the upper end of the range documented in Zhang and Chen's (2020) meta-analysis, which reported generally positive but variable effects across studies. This comparatively strong performance may be attributable to several features of the EDEP: its relatively long duration (eight weeks, compared to the four weeks in Yılmaz et al., 2020, which produced null results), its multi-modal pedagogical approach (incorporating nine distinct activity types rather than relying on a single instructional format), and its direct delivery by the researcher, which ensured consistency and fidelity of implementation.

Within the Turkish literature, the findings are consistent with Cevher-Kalburan and Alisinanoğlu (2010), who also found significant improvements in environmental attitudes following a structured program, and with Ahi (2015), who documented positive effects on children's environmental mental models. The present study extends these findings in an important way: by simultaneously assessing both behavioral and attitudinal outcomes, it demonstrates that the EDEP's effects are not limited to a single domain but span both what children know and feel about the environment (awareness and attitudes) and what they actually do (observable sustainability behaviors). This multi-domain finding is particularly significant because, as Hungerford and Volk (1990) argued, knowledge and attitudes alone do not guarantee behavioral change—the gap between environmental awareness and environmental action is well documented in the literature. The EDEP appears to have been successful in bridging this gap, at least in the short term.

The Control Group Paradox: Gains and an Unexpected Decline

One of the most instructive aspects of the present findings is the pattern of results in the control group, which was not uniformly stable as initially hypothesized. On the SBAS, the control group showed statistically significant pre-to-post gains on both sub-dimensions, though with medium effect sizes (r = .41–.54) that were substantially smaller than the experimental group's large effects (r = .88). Several explanations are plausible. First, developmental maturation over the eight-week period may have contributed to improved sustainability behaviors, as children in this age range are rapidly developing their cognitive and social capacities. Second, the standard MoNE curriculum, while not including a dedicated environmental education component, may contain incidental environmental content that contributes to some growth. Third, test-retest effects cannot be ruled out, as children's familiarity with the SBAS items at post-test may have influenced their teachers' ratings. Regardless of the explanation, the critical finding is that the between-group comparisons clearly demonstrate that the EDEP produced gains substantially above and beyond those achievable through the standard curriculum or natural development alone.

Perhaps the most intriguing and unexpected finding of this study is the significant decline in the control group's Environmental Awareness scores on the EAASPC. While 16 of 24 control children showed decreased awareness scores at post-test, the experimental group's awareness scores improved significantly. This divergent pattern is remarkable and warrants careful interpretation. Several non-mutually-exclusive explanations deserve consideration.

First, the modest reliability of the EAASPC Environmental Awareness subscale (α = .67) may have introduced considerable measurement instability, making scores susceptible to random fluctuation—particularly in the absence of targeted instruction that might anchor and stabilize responses. Second, environmental awareness in young children may be inherently fragile: without structured reinforcement, incidental environmental knowledge acquired earlier (e.g., from media, family conversations, or prior school activities) may dissipate over time. This interpretation is consistent with Heimlich and Ardoin's (2008) observation that environmental attitudes and knowledge may not be stable without sustained reinforcement. Third, the control group's teachers may have de-emphasized environmental content during the study period, inadvertently reducing children's exposure to environmental themes. Fourth, a testing effect may have operated differentially: at pre-test, novelty of the illustrated items may have elicited more engaged responses, while at post-test, without intervening environmental instruction, children may have been less motivated or attentive. Whatever the underlying mechanism, this finding underscores a theoretically important point: environmental awareness in preschool children should not be assumed to be stable or self-sustaining, and the absence of targeted intervention may actually allow previously acquired awareness to erode.

Theoretical and Practical Implications

From a theoretical perspective, the present findings support the applicability of social learning theory and constructivist frameworks to early childhood environmental education. The EDEP's success in producing both attitudinal and behavioral change suggests that programs designed around modeling, reinforcement, and active experiential learning can effectively bridge the knowledge–action gap in young children—a finding that extends Hungerford and Volk's (1990) model to the preschool population. The divergent outcomes between experimental and control groups on the EAASPC Environmental Awareness subscale further suggest that environmental cognition in early childhood may be more state-dependent and context-sensitive than previously assumed, reinforcing the need for sustained, intentional environmental instruction.

From a practical standpoint, the large effect sizes observed across both instruments argue compellingly for the integration of structured environmental education programs into preschool curricula. The EDEP's design features—multi-modal activities, expert-reviewed content, twice-weekly delivery over eight weeks, and integration with existing curricular goals—provide a feasible template for implementation in other preschool settings. The finding that a four-week program (Yılmaz et al., 2020) was ineffective while the present eight-week program produced large effects suggests a dose-response relationship that policymakers should consider when allocating curricular time to environmental education.

Limitations

Several limitations must be acknowledged when interpreting these findings. First, the study was conducted in a single public school in a single district (Serdivan, Sakarya), and the sample was drawn from only two classrooms. This limits the generalizability of the findings to other socioeconomic, cultural, and geographic contexts within Türkiye or internationally. Replication across multiple sites with more diverse populations is essential before strong generalizations can be made.

Second, the SBAS was completed by classroom teachers who were aware of group assignments, introducing the possibility of observer expectancy bias—teachers may have unconsciously rated experimental children more favorably because they knew the EDEP was being conducted. Although teacher-report observation is a standard and practical approach in early childhood research, future studies should employ blinded assessors or include direct behavioral observation by independent raters. Inter-rater reliability was not formally assessed in this study, which represents an additional methodological limitation.

Third, the EAASPC's relatively modest psychometric properties (α = .67) introduce greater measurement error than would be ideal, particularly for the Environmental Awareness subscale. While the large between-group effects provide reassurance that genuine differences were detected, the unexpected control group decline on this subscale may partly reflect measurement instability rather than a true decline in awareness. Future studies should consider using more recently developed and psychometrically stronger instruments when available.

Fourth, the EDEP was both developed and delivered by the researcher, which limits the ability to disentangle the effects of the program's content from the researcher's personal characteristics, teaching style, and enthusiasm—factors that may not be present when the program is delivered by other educators. Independent replication by different implementers is needed to establish the program's generalizability beyond its developer.

Fifth, only immediate post-test data were collected. It is therefore unknown whether the improvements observed in the experimental group persist over weeks, months, or years following the intervention. Longitudinal follow-up studies are essential to determine the durability of these effects and to assess whether early gains translate into sustained pro-environmental behaviors in later childhood and beyond.

Finally, the use of convenience sampling and intact classrooms, while common in educational research, limits causal inference. Although baseline equivalence was confirmed on all outcome measures, unmeasured pre-existing differences between the groups cannot be entirely ruled out. Future studies with larger samples and, where feasible, cluster-randomized designs would provide stronger evidence for causal claims.

Conclusion and Recommendations

This study provides robust evidence that a structured, multi-component Eco-Friendly Education Program can produce statistically significant and practically meaningful improvements in both sustainability behaviors and environmental awareness and attitudes among preschool children aged 60–72 months. Across ten separate statistical tests—encompassing within-group pre–post comparisons and between-

group post-test comparisons on two instruments and four sub-dimensions—the results consistently favored the experimental group, with effect sizes in the medium-to-large range. The particularly striking finding that all 20 experimental children showed improved sustainability behavior scores, with no exceptions, speaks to the program's broadly effective impact across individual differences in temperament, background, and initial ability level.

Equally informative was the control group's mixed performance: while some improvement occurred on sustainability behaviors (suggesting that development and standard curriculum contribute some growth), the unexpected decline in environmental awareness underscores the fragility of unprompted environmental cognition in young children and reinforces the argument that dedicated, structured environmental education—not merely incidental exposure—is necessary to cultivate and sustain environmental awareness during the preschool years.

Based on the convergence of findings across both instruments and all sub-dimensions, the following recommendations are offered:

First, given the large effect sizes observed (r = .75–.85 on between-group comparisons), educational policymakers—particularly within the Turkish Ministry of National Education—should consider integrating structured, multi-component environmental education programs into the national preschool curriculum as a standard rather than supplementary component.

Second, the contrast between the present study's positive findings and Yılmaz et al.'s (2020) null results with a four-week program suggests that a minimum duration of six to eight weeks should be targeted when designing environmental education interventions for preschoolers.

Third, future replications should employ blinded outcome assessment—that is, evaluators who are unaware of children's group assignments—and should establish inter-rater reliability for observational measures to address the potential for observer bias.

Fourth, the unexpected decline in control group environmental awareness scores represents an empirically novel finding that warrants dedicated investigation. Studies specifically designed to assess the stability and trajectory of environmental cognition in preschool children, in the presence and absence of structured environmental education, would make a valuable contribution to both developmental psychology and environmental education research.

Fifth, longitudinal follow-up studies are essential to determine whether the gains observed in this study persist beyond the immediate post-test period and translate into sustained pro-environmental habits in later childhood.

Sixth, future research should employ larger and more diverse samples across multiple schools and geographic regions, with attention to parental involvement, home environmental practices, and socioeconomic factors as potential moderating variables.

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