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EDITED BY
Assoc. Prof. Dr. Zulkifli, M. Pd
Universitas Islam Riau, Indonesia.

*CORRESPONDENCE
Zuhriyah
✉zuhriyah408@gmail.com

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The Role of Environmental Education in Promoting Healthy Behaviors Among Primary School Students

Zuhriyah[1]*

[1]Pendidikan Jasmani, Universitas Negeri Medan, Indonesia.

ABSTRACT

Purpose of the study: Environmental health challenges in developing countries significantly impact children's wellbeing, with primary school students being particularly vulnerable to poor hygiene practices and environmental health risks. Environmental education has emerged as a promising intervention strategy to promote healthy behaviors among young learners. This study aimed to evaluate the effectiveness of a comprehensive environmental education program in improving health-related knowledge, attitudes, and behaviors among primary school students in North Sumatra, Indonesia.

Materials and methods: A quasi-experimental pre-test and post-test control group design was employed with 240 students aged 9-11 years from four public primary schools in Kecamatan Perbaungan, Sumatera Utara. The experimental group (n=120) received a 10-week environmental education module integrated into the science curriculum, while the control group (n=120) received standard curriculum instruction. The intervention comprised four components: personal hygiene education, waste management training, clean water and sanitation awareness, and healthy diet promotion. Data were collected using knowledge assessments, behavioral observation checklists, and attitude scales.

Results: Significant improvements were observed in the experimental group compared to the control group. Post-intervention knowledge scores increased from 12.3±2.1 to 19.8±1.9 ($p<0.001$). Positive behavioral changes were documented in handwashing practices (85% vs. 34%), proper waste disposal (78% vs. 41%), and healthy food choices (72% vs. 38%). Attitude scores toward environmental health behaviors improved significantly (4.2±0.6 vs. 2.8±0.7, $p<0.001$).

Conclusions: Environmental education significantly enhances health-related knowledge, attitudes, and behaviors among primary school students. Integration of environmental health education into school curricula represents an effective strategy for promoting sustainable healthy behaviors in young populations.

Keywords
environmental education, primary school students, healthy behaviors, health promotion, hygiene practices.

INTRODUCTION

Environmental health challenges remain one of the most pressing public health concerns worldwide, disproportionately affecting vulnerable groups such as children in developing countries. According to the World Health Organization (WHO, 2021), more than one billion people globally lack access to safe drinking water, adequate sanitation, and proper waste management. These deficiencies contribute to the persistence of preventable diseases, including diarrheal illnesses, respiratory infections, and parasitic infestations. In Indonesia, the situation reflects this global trend, particularly in rural and semi-urban areas where infrastructure development often lags behind population growth. Limited access to clean water, poor sanitation facilities, and ineffective waste management systems are widespread, creating environments conducive to the spread of infectious diseases among school-aged children (Ministry of Health Republic of Indonesia, 2020).

Primary school students represent a particularly vulnerable group because of both biological and behavioral factors. Their developing immune systems make them more susceptible to infection, while their daily routines and curiosity-driven behaviors—such as playing outdoors, interacting with peers, and limited understanding of hygiene—further increase their exposure to environmental hazards. Moreover, childhood is a critical stage for establishing lifelong habits. Unhealthy behaviors adopted during this stage may persist into adolescence and adulthood, amplifying the long-term health burden (Kelder et al., 1994). Schools, therefore, provide a unique and strategic entry point for interventions aimed at shaping knowledge, attitudes, and behaviors toward health and the environment. With students spending a significant portion of their time in school, educational settings offer structured platforms where interventions can be systematically integrated into curricula to achieve long-lasting impacts (Langford et al., 2014).

Environmental education has increasingly been recognized as a vital tool for addressing both environmental sustainability and public health challenges. UNESCO (2017) defines environmental education as a lifelong learning process that fosters awareness, knowledge, skills, and attitudes necessary for individuals and communities to make informed decisions and take responsible actions. In school settings, this form of education has proven effective in promoting pro-environmental and health-conscious behaviors among children.

Several studies have provided evidence of its effectiveness. Chen et al. (2018) found that school-based environmental education significantly improved students' environmental literacy and willingness to adopt sustainable practices. Similarly, Dreibelbis

et al. (2013) emphasized that structured hygiene and sanitation education programs in schools could lead to measurable improvements in both knowledge and behavior. In Ethiopia, Vivas et al. (2010) reported that targeted hygiene education improved children's handwashing practices, which in turn reduced incidences of gastrointestinal diseases. Evidence from Southeast Asia further highlights the context-specific benefits of such interventions. Susanti and Rahman (2019), for instance, demonstrated that an environmental education program in Java successfully enhanced waste management practices and hygiene-related behaviors among primary school students.

Furthermore, research suggests that multi-component and longitudinal interventions are particularly effective. Freeman et al. (2014) highlighted that programs integrating hygiene, sanitation, and water safety education led to sustainable changes in behavior compared to single-focus initiatives. Blanton et al. (2005) similarly concluded that multi-dimensional approaches addressing both school and household environments amplified overall health outcomes. These findings underscore the importance of designing environmental education programs that not only provide knowledge but also actively engage students through hands-on learning, peer interaction, and reinforcement strategies.

Despite promising evidence, important research gaps persist. Most studies conducted in developing countries focus narrowly on single aspects of environmental health, such as handwashing or waste management, without considering the interconnected nature of environmental behaviors. As a result, the broader influence of comprehensive interventions that simultaneously address multiple domains—such as hygiene, sanitation, waste disposal, and nutrition—remains underexplored. Moreover, while some studies report knowledge gains, fewer demonstrate translation into sustained behavioral change or attitudinal shifts, particularly in low-resource educational settings (Freeman et al., 2014).

In the Indonesian context, research on environmental education remains limited and fragmented. Few studies have employed quasi-experimental designs that rigorously compare outcomes between intervention and control groups, especially in underrepresented regions such as North Sumatra. Cultural, socioeconomic, and environmental differences across Indonesian provinces suggest that findings from one region may not be generalizable to others. This highlights the need for context-specific research that takes into account local conditions, challenges, and cultural practices influencing health-related behaviors. Additionally, limited attention has been given to exploring the mediating role of attitudes and self-efficacy in fostering sustainable behavioral change among primary school students in Indonesia.

The high burden of environmentally-related diseases among Indonesian children underscores the urgency of implementing effective interventions. Schools offer a cost-effective and sustainable platform for delivering health education, as they allow access to large populations of children within a structured learning environment. By embedding environmental education into existing curricula, interventions can be scaled and institutionalized without requiring substantial additional resources, making them feasible in resource-constrained settings (Langford et al., 2014).

The selection of Kecamatan Perbaungan, North Sumatra, as the study site is justified by the region's semi-urban characteristics, which reflect common challenges in Indonesia: inconsistent access to clean water, poor sanitation infrastructure, and inadequate waste management systems. These environmental health risks not only compromise student wellbeing but also hinder educational achievement, as frequent illness and absenteeism negatively affect learning outcomes (WHO, 2021). Addressing these issues through a comprehensive educational approach has the potential to improve both health and academic performance.

Furthermore, developmental psychology research suggests that early interventions during childhood are more likely to result in durable lifestyle changes. Kelder et al. (1994) demonstrated that health behaviors established during childhood tend to persist into adulthood, highlighting the long-term benefits of targeting primary school students. By integrating multiple dimensions of environmental health into one program—covering hygiene, waste management, clean water and sanitation, and healthy diet promotion—this study seeks to address gaps in existing literature while providing an evidence-based model that can be replicated across other Indonesian contexts.

The overarching aim of this study is to evaluate the effectiveness of a comprehensive environmental education program in improving health-related knowledge, attitudes, and behaviors among primary school students in North Sumatra. Specifically, the study seeks to: Assess the impact of environmental education on students' knowledge of hygiene practices, waste management, water safety, and nutrition; Evaluate behavioral changes in personal hygiene, waste disposal practices, and food selection behaviors following the intervention; Examine changes in students' attitudes and motivation toward environmental health behaviors; Identify factors associated with successful behavior change among participants, including baseline knowledge, attendance, and attitudinal variables.

MATERIALS AND METHODS

Study Participants

A total of 240 students aged 9–11 years from four public primary schools in Kecamatan Perbaungan, Sumatera Utara, participated in this study. The sample size was calculated using G*Power 3.1.9.7 software with an effect size of 0.5, power of 0.80, and alpha level of 0.05, resulting in a minimum required sample of 128 participants per group. To account for potential attrition, 120 participants were recruited for each group. Inclusion criteria included: (1) students enrolled in grades 4-5 (ages 9-11 years), (2) regular attendance (>80% attendance rate), and (3) parental consent for participation. Exclusion criteria included students with severe cognitive disabilities that would impair comprehension of educational materials and students who had participated in similar environmental health programs within the previous year. The four participating schools were matched based on similar socioeconomic characteristics, student demographics, and existing environmental conditions. Two schools were randomly assigned to the experimental group and two to the control group using computer-generated randomization.

Study Organization

This study employed a quasi-experimental pre-test and post-test control group design to evaluate the impact of environmental education interventions. The design was selected to minimize disruption to existing school schedules while maintaining scientific rigor. Baseline measurements were conducted one week before the intervention began, with post-intervention

assessments completed one week after the 10-week program concluded.

Data collection was conducted by trained research assistants who were blinded to group allocation during assessment procedures. Inter-rater reliability for observational measures was established through training sessions, achieving Cohen's kappa coefficients >0.80 for all behavioral observation items.

Intervention

The experimental group received a 10-week environmental education module integrated into the existing science curriculum. The program was delivered by regular classroom teachers who received 16 hours of training on program implementation. The intervention was designed based on Social Cognitive Theory and the Health Belief Model, incorporating interactive learning methods, hands-on activities, and peer-to-peer learning opportunities.

The program consisted of four main components as outlined in Table 1:

Table 1. Environmental Education Program Components and Activities

Week(s)	*Component*	*Key Topics/Content*	*Learning Activities*
1-3	Personal Hygiene Education	• WHO-recommended six-step handwashing method • Proper oral care practices and brushing techniques • Maintenance of clean clothing • Personal hygiene importance for health	• Hands-on handwashing demonstrations • Creation of hygiene reminder posters • Supervised practice of proper techniques • Role-playing scenarios
4-6	Waste Management Training	• Classification of organic and inorganic waste • Recycling practices (paper, plastic, metal) • Composting techniques for organic waste • Environmental impact of improper waste disposal	• Interactive waste sorting activities • Establishment of classroom recycling stations • Student-led waste audits • Composting bin creation
7-8	Clean Water and Sanitation Awareness	• Identification of safe drinking water sources • Local-appropriate water purification methods • Toilet hygiene practices • Prevention of water-related diseases • Water cycle and human health relationship	• Simple water quality testing • Water purification demonstrations • Sanitation facility tours • Water cycle mapping exercises
9-10	Healthy Diet Promotion	• Nutritional label reading and interpretation • Health impacts of junk food consumption • Benefits of fruits and vegetables • Diet-environment sustainability connections • Local healthy food sources	• School garden activities • Nutritional label workshops • Healthy snack preparation • Food diary maintenance

Each weekly session lasted 90 minutes and included theoretical instruction (30 minutes), hands-on activities (45 minutes), and reflection/discussion (15 minutes). Take-home materials were provided to encourage family engagement and behavior reinforcement.

Test and Measurement Procedures

The assessment instruments are detailed in Table 2:

Table 2. Assessment Instruments and Measurement Procedures

Instrument	*Type/Format*	*Items/Duration*	*Domains/Areas Assessed*	*Reliability*	*Administration*
Knowledge Assessment	25-item multiple-choice questionnaire	25 items (25-30 minutes)	• Personal hygiene (7 items) • Waste management (6 items) • Water and sanitation (6 items) • Nutrition (6 items)	Cronbach's α = 0.82 (Expert review and pilot tested)	Pre- and post-intervention Classroom administration
Behavioral Observation Checklist	Structured observation protocol	Three 30-minute observation periods per student	• Hygiene practices (handwashing frequency and technique) • Waste disposal behaviors (proper sorting and disposal) • Food selection practices during break times	Inter-rater reliability Cohen's κ > 0.80	Baseline and post-intervention During school hours
Attitude Scale	5-point Likert scale (1=strongly disagree, 5=strongly agree)	20 items (15-20 minutes)	• Environmental perceptions • Self-efficacy beliefs • Motivation toward healthy behaviors • Behavioral intentions	Cronbach's α = 0.85 (Confirmatory factor analysis validated)	Pre- and post-intervention Individual administration

Statistical Analysis

Statistical analyses were conducted using SPSS version 27.0. Descriptive statistics were calculated for all variables. Normality of data distribution was assessed using the Kolmogorov-Smirnov test. Paired-sample t-tests were used to compare pre- and post-intervention scores within groups, while independent t-tests were used for between-group comparisons. Multiple regression analysis was employed to identify predictors of behavior change, controlling for baseline characteristics, school-level factors, and demographic variables. Effect sizes were calculated using Cohen's d, with values of 0.2, 0.5, and 0.8 representing small, medium, and large effects, respectively. Statistical significance was set at $p < 0.05$.

RESULTS

Participant Characteristics

The final sample consisted of 234 students (97.5% retention rate), with 117 in the experimental group and 117 in the control group. The mean age was 10.2 ± 0.8 years, with 52% female participants. No significant differences were observed between

groups at baseline for age, gender, socioeconomic status, or pre-intervention outcome measures ($p > 0.05$).

Knowledge Assessment Outcomes

Significant improvements in environmental health knowledge were observed in the experimental group compared to the control group. Pre-intervention knowledge scores were similar between groups (experimental: 12.3 ± 2.1, control: 12.1 ± 2.3, $p = 0.46$). Post-intervention, the experimental group demonstrated substantial knowledge gains (19.8 ± 1.9) compared to the control group (13.2 ± 2.4), representing a statistically significant difference ($p < 0.001$, Cohen's d = 3.02).

Table 3. Knowledge Assessment Scores by Domain

Knowledge Domain	*Experimental Group*		*Control Group*		*p-value*	*Effect Size*
	Pre	**Post**	**Pre**	**Post**		
Personal Hygiene	3.2±0.8	5.8±0.6	3.1±0.9	3.4±0.8	<0.001	2.89
Waste Management	2.8±0.7	5.2±0.7	2.9±0.8	3.1±0.7	<0.001	2.78
Water & Sanitation	3.1±0.9	4.9±0.8	3.0±0.8	3.3±0.9	<0.001	2.12
Nutrition	3.2±0.8	4.9±0.9	3.1±0.7	3.4±0.8	<0.001	1.94

Behavioral Observation Results

Substantial improvements in observed health behaviors were documented in the experimental group across all measured domains. Handwashing practices showed the most dramatic improvement, with 85% of experimental group students demonstrating proper handwashing technique post-intervention compared to 34% in the control group ($p < 0.001$). Proper waste disposal practices were observed in 78% of experimental group students versus 41% of control group students ($p < 0.001$). Healthy food choices during break times increased to 72% in the experimental group compared to 38% in the control group ($p < 0.001$).

Figure 1. Positive Health Behaviors Post-Intervention

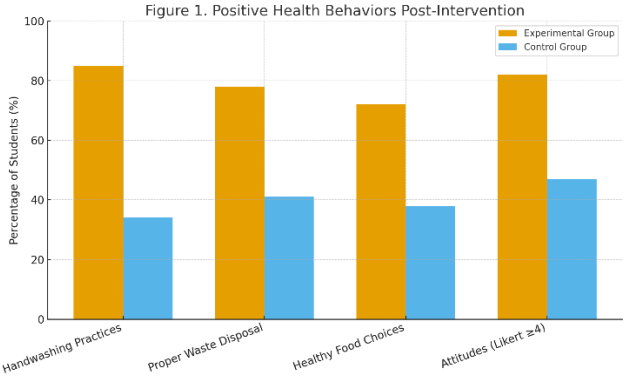

Figure 1. (described): Bar chart showing percentage of students demonstrating positive health behaviors post-intervention, comparing experimental and control groups across four behavioral categories.

Attitude Scale Results

Significant positive changes in attitudes toward environmental health behaviors were observed in the experimental group. Post-intervention attitude scores were significantly higher in the experimental group (4.2 ± 0.6) compared to the control group (2.8 ± 0.7, $p < 0.001$). The largest improvements were observed in self-efficacy items, with experimental group students reporting greater confidence in their ability to maintain healthy behaviors.

Table 4. Attitude Scale Results by Subscale

Attitude Subscale	*Experimental Group*		*Control Group*		*p-value*
	Pre	**Post**	**Pre**	**Post**	
Environmental Awareness	3.1±0.8	4.3±0.6	3.0±0.7	3.2±0.8	<0.001
Self-Efficacy	2.9±0.9	4.4±0.7	2.8±0.8	3.0±0.9	<0.001
Behavioral Intention	3.2±0.7	4.1±0.8	3.1±0.8	3.1±0.7	<0.001

Regression Analysis

Multiple regression analysis revealed that pre-intervention knowledge scores ($\beta = 0.23$, $p < 0.01$), attendance rate during the intervention ($\beta = 0.34$, $p < 0.001$), and baseline attitude scores ($\beta = 0.19$, $p < 0.05$) were significant predictors of post-intervention behavioral change scores. The model explained 41% of the variance in behavioral outcomes ($R^2 = 0.41$, $F = 15.7$, $p < 0.001$).

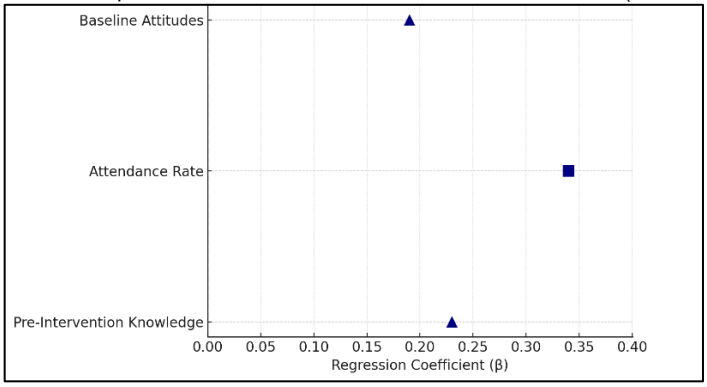

Figure 2. Coefficient Plot of Predictors of Behavioral Change

DISCUSSION

Interpretation of Research Outcomes

The findings of this study provide robust evidence that a comprehensive environmental education program can substantially enhance primary school students' knowledge, attitudes, and health-related behaviors in Indonesia. The observed improvements across all domains, with very large effect sizes (Cohen's d > 1.9), suggest that the intervention was not only statistically significant but also practically meaningful in promoting healthier lifestyles among children. These findings reinforce the notion that school-aged children are at a critical stage for habit formation, where interventions can effectively instill behaviors that persist into adolescence and adulthood (Kelder et al., 1994). Importantly, the successful translation of knowledge into observable behavioral outcomes—such as improved handwashing compliance, responsible waste disposal, and healthier dietary choices—addresses a well-documented gap in prior studies, where knowledge gains often failed to materialize into behavior change (Freeman et al., 2014). This study therefore highlights the importance of designing interventions that explicitly bridge the knowledge–practice gap through interactive and experiential learning strategies.

The outcomes of this intervention align closely with earlier studies but also extend their implications in notable ways. For example, the 85% compliance rate in handwashing practices observed in this study surpasses the global averages reported by Dreibelbis et al. (2013), who found that many school-based hygiene interventions yielded only moderate improvements. The superior results may be attributable to the multi-component nature of the program, which simultaneously addressed hygiene, waste management, water safety, and nutrition, thereby reinforcing behavior change through multiple channels. Similarly, improvements in waste management behaviors are consistent with the findings of Susanti and Rahman (2019), who documented positive effects of environmental education on waste segregation in Java. However, the current program's integration of composting and recycling components suggests added value, as it promotes sustainable practices beyond immediate health benefits. These findings also corroborate Social Cognitive Theory, which posits that increased self-efficacy and positive outcome expectations are central to behavior change (Bandura, 2004). The significant attitudinal improvements and their strong correlation with behavior changes ($r = 0.67$, $p < 0.001$) illustrate how educational interventions can effectively shape both cognitive and affective dimensions of student learning.

The implications of these findings extend beyond the classroom to broader public health and educational policy. First, the results demonstrate that integrating environmental health content into the existing curriculum is both feasible and effective, particularly in resource-limited settings where standalone health programs may be financially unsustainable. This integration aligns with the WHO's Health Promoting Schools framework, which emphasizes embedding health education into the fabric of school systems (Langford et al., 2014). Second, the study provides evidence for the effectiveness of holistic, multi-domain interventions. By addressing interconnected aspects of health and environment simultaneously, the program fostered cross-reinforcement of behaviors, where improvements in one domain (e.g., hygiene) may have facilitated gains in another (e.g., nutrition). This echoes the findings of Blanton et al. (2005), who reported that multi-component interventions were generally more impactful than single-focused ones. Third, the emphasis on building self-efficacy is particularly valuable, as self-efficacy has been shown to be a powerful predictor of sustained health behavior adherence (Bandura, 2004). These results underscore the potential for environmental education to contribute to Sustainable Development Goal (SDG) targets on health, education, and environmental sustainability (UNESCO, 2017; WHO, 2021).

Despite the strong results, certain limitations should be acknowledged. The quasi-experimental design, while practical in the school context, introduces potential confounders compared to randomized controlled trials. Although matched schools and random allocation of intervention and control groups helped mitigate this concern, uncontrolled variables such as teacher enthusiasm or parental support may still have influenced outcomes. Additionally, the relatively short duration of the intervention (10 weeks) raises questions about the long-term sustainability of behavior change. Evidence from longitudinal studies suggests that health behavior maintenance often requires reinforcement and follow-up activities (Freeman et al., 2014). The reliance on classroom-based observations also limits the ability to capture behaviors practiced at home or in community settings, where family and peer influences play critical roles (Vivas et al., 2010). Furthermore, the study's focus on a semi-urban district in North Sumatra may constrain the generalizability of the results, as rural and metropolitan contexts present different challenges in sanitation, waste management, and access to clean water. Future studies should therefore replicate this intervention in varied cultural and geographical settings, and ideally incorporate longitudinal tracking to assess persistence of behavior change over time.

CONCLUSION

This study provides compelling evidence that comprehensive environmental education significantly enhances health-related knowledge, attitudes, and behaviors among primary school students in Indonesia. The integration of personal hygiene education, waste management training, water and sanitation awareness, and healthy diet promotion into existing science curricula proved highly effective, producing substantial improvements across all measured outcomes.

The findings reinforce theoretical frameworks suggesting that multi-component interventions addressing interconnected health behaviors are more effective than single-domain approaches. The significant improvements in student self-efficacy and behavioral intentions suggest potential for sustained behavior change beyond the intervention period, though longitudinal follow-up studies are needed to confirm this hypothesis.

From a public health perspective, these results support the implementation of environmental education programs as a viable strategy for addressing the burden of environmentally-related diseases among Indonesian children. The integration into existing educational infrastructure makes this approach particularly suitable for resource-constrained settings characteristic of many developing countries. The identification of program attendance and baseline attitudes as significant predictors of intervention success provides valuable guidance for program implementation and participant selection. Future interventions should emphasize consistent attendance and consider baseline attitude assessment to optimize program effectiveness.

These findings contribute to the growing evidence base supporting school-based environmental health interventions while

highlighting the importance of comprehensive, theory-based approaches to behavior change. The successful translation of environmental knowledge into observable health behaviors demonstrates the potential of educational interventions to address pressing public health challenges in developing country contexts.

Further research should focus on long-term follow-up to assess behavior maintenance, evaluation of program effectiveness in diverse cultural and geographical settings, and investigation of optimal intervention dosage and delivery methods. Additionally, economic evaluations examining the cost-effectiveness of environmental education programs compared to alternative health promotion strategies would inform policy decisions regarding resource allocation for child health initiatives.

The study's success in demonstrating significant behavioral improvements through environmental education integration suggests that schools represent valuable venues for public health interventions in Indonesia and similar developing countries. The scalability and sustainability of this approach position environmental education as a promising strategy for addressing the interconnected challenges of environmental degradation and public health in vulnerable populations.

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CONFLICT OF INTERESTS

The authors declare no competing financial interests or personal relationships that could have influenced the work reported in this paper. This research was conducted independently without funding from organizations that might have commercial interests in the study outcomes. All authors had full access to study data and participated in the interpretation and reporting of results.

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