Effectiveness of Incenerator-Based Practice in Improving Student's Environmental Health Care Behavior

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ABSTRACT

The waste emergency in Yogyakarta, following the collapse of the centralized waste management system and the closure of the Final Disposal Site (FDS), has necessitated the implementation of decentralized and self-managed waste solutions within institutional settings. In this study, the effectiveness of integrating incinerator technology as a practice-based intervention to enhance Environmental Health Care Behavior (EHCB) among university students was investigated. A quantitative pre-experimental study employing a one-group pretest–posttest design was conducted using total sampling (n = 46). The intervention consisted of structured demonstrations and supervised hands-on operation of a campus mini-incinerator embedded within environmental health learning activities. EHCB scores were analyzed using a paired-sample t-test. A statistically significant increase was identified between the pre-intervention mean score (Mean = 45.60) and the post-intervention mean score (Mean = 52.80), with p < 0.001. An improvement of 15.79%, accompanied by a large effect size, was observed. These findings indicate that experiential engagement with environmental technology enhances self-efficacy and facilitates the transformation of knowledge into responsible waste management behavior. The results underscore the importance of technology-enhanced experiential learning as an institutional strategy for strengthening sustainable environmental health practices within decentralized waste management systems.

Keywords: Incenerator; Environmental Health; Waste Emergency; Health Care Behavior; Yogyakarta

1. INTRODUCTION

Waste management is now widely recognized as a global environmental and public health crisis (Gull et al., 2025). Rapid population growth and changes in consumption patterns have led to a substantial increase in solid waste generation (Zhang et al., 2025). At the national level, Indonesia faces significant challenges (Sembiring et al., 2024). The Sistem Informasi Pengelolaan Sampah Nasional (SIPSN) reported that in 2024, total waste generation reached 37.3 million tons per year across 342 districts/cities, with 11.3 million tons remaining inadequately managed (Wiharja et al., 2025).

Efforts to manage waste in Indonesia continue to face substantial gaps. Data indicate that the volume of unmanaged waste remains high, and most final disposal sites (FDS) still rely on unhygienic open

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dumping methods (Frigo et al., 2025). Open dumping methods, this gap generates serious environmental and health impacts, including open burning practices that release toxic pollutants (Sheriff et al., 2025). Decentralized technological solutions, such as modified incinerators, are increasingly recommended to minimize the volume of waste transported to landfills (Taweesan et al., 2025). In addition, incinerators can improve combustion quality while maintaining minimal levels of pollution (Astuti et al., 2026).

Daerah Istimewa Yogyakarta (DIY), as a center of education and tourism, faces extraordinary pressure on its waste infrastructure (Rindrasih et al., 2024). The region's daily waste volume continues to increase sharply, driven by both permanent residents and non-permanent populations, including students and tourists. Limited landfill capacity and overcapacity conditions have triggered a waste management crisis in the area (Suhardono et al., 2024). This situation culminated in repeated declarations of a "waste emergency" by the Daerah Istimewa Yogyakarta, primarily due to the overcapacity of the local FDS of Piyungan and periodic closures of its operational access (Tirto, 2023). The local FDS in Piyungan was forced to operate beyond its standards until its eventual permanent closure, resulting in an increased proportion of unmanaged waste in the region (Tempo, 2024) and compelling communities to adopt independent waste management practices (Soto-Paz et al., 2023).

The closure of the Piyungan landfill represents a clear manifestation of the failure of the centralized "collect–transport–dispose" waste management model. This centralized approach has been demonstrated to be unsustainable due to high logistical expenditures, the carbon footprint associated with long-distance transportation, and the physical constraints of landfill capacity (SIPSN, 2024; Setyoaji, D. U., Djuwari, A. K., & Pradana, 2020). Consequently, the crisis has necessitated a comprehensive paradigm shift toward decentralized waste management systems.

This emerging paradigm prioritizes the waste management hierarchy, namely reduce (waste minimization), sort (source separation), and process (reuse and final treatment). A transformation in institutional roles is therefore required, in which responsibility for waste is assumed by the generating entities rather than limited to disposal practices. As a result, all waste-producing institutions, including educational institutions, are obligated to invest in independent waste processing technologies (Sapkota & Pariatamby, 2026).

The regional waste crisis constitutes an important contextual background; however, the present study specifically evaluates a student-level institutional intervention designed to improve Environmental Health Care Behavior (EHCB) (Liu et al., 2024). In response to the ongoing crisis and the increasing demand for self-managed waste systems, Universitas Islam Mulia Yogyakarta (UIMY) has undertaken a strategic initiative. A small-scale incinerator technology has been developed and implemented within the campus environment. The incinerator was selected as an appropriate technological solution to substantially reduce waste volume through controlled high-temperature combustion, particularly for operational waste generated from academic and dormitory activities that cannot be recycled (Ani et al., 2023).

The presence of an incinerator on campus has been integrated as a living laboratory and a practice-based intervention medium within Environmental Health courses (Khanzada et al., 2024). This integration is crucial, as theoretical learning alone has been shown to be less effective in changing behavior compared with practice-based interventions that enhance self-efficacy (Zhou et al., 2024). This study is theoretically grounded in Social Cognitive Theory (Bandura), which emphasizes self-efficacy as a key determinant of behavioral change (EM, 2022). Mastery experience, gained through direct engagement in performing a task, is considered the most powerful source of self-efficacy. By integrating incinerator operation into experiential learning, this intervention provides mastery experiences that are expected to strengthen Environmental Health Care Behavior (EHCB) (Wang Y, Zhu J, Xu Z, Dai X, Chen K, 2023). Therefore, the implementation of this technology serves as a critical means of strengthening students' Environmental Health Care Behavior, particularly in the responsible sorting and processing of waste (Nabi et al., 2024).

This study builds upon established behavioral intervention approaches; however, its novelty is reflected in the integration of technological practice, experiential learning, and behavioral evaluation within an actual institutional waste-emergency setting. The intervention is therefore conceptualized as a technology-enhanced experiential learning model rather than as a purely technological or theoretical innovation.

Based on the waste crisis in the Yogyakarta region and the initiative undertaken by Universitas Islam Mulia Yogyakarta, the study was designed to examine the effectiveness of implementing incinerator technology as a practice-based intervention to improve students' awareness scores. A pre-experimental one-group pretest–posttest design was employed (Chaeraty Syam, N., Khasan, A., & Sumarmi, 2023). Empirical evidence is expected to be generated regarding the impact of technology-based interventions on strengthening students' environmental health care culture. It is hypothesized that a statistically significant difference exists in EHCB scores before and after the implementation of the practice-based intervention.

The success of waste management technology implementation at the institutional level is largely determined by the quality of individual behavior among those involved (Azwar, 2022). Therefore, empirical investigation is required to validate the extent to which technological innovation, when combined with educational practice, can serve as a catalyst for positive behavioral change (Rika Yuliana, W. Wasino, 2025). Based on this urgency, the present study aims to quantitatively examine the effectiveness of implementing incinerator technology in improving students' EHCB.

2. METHODS

This study employed a quantitative pre-experimental design using a one-group pretest–posttest approach to measure changes in students' EHCB before and after an intervention involving the implementation of incinerator technology. The design involved a single group measured at the pretest stage (O1), followed by an intervention (X) consisting of demonstrations and operational practice of the incinerator, and subsequently measured again at the posttest stage (O2). The study was conducted in October 2025 within the Undergraduate Health Administration Study Program at Universitas Islam Mulia Yogyakarta. Ethical clearance for this study was obtained from the Ethics Committee of Universitas Islam Mulia Yogyakarta Protocol No. 035/001/017.UIMY/XI/2026. Informed consent was obtained from all participants prior to data collection.

The study population comprised all students in the program, while the sample included students who had completed the Environmental Health course. A total sampling technique was employed; thus, all students meeting the inclusion criteria were involved as respondents. The study included two variables: the independent variable was the use of incinerator technology, and the dependent variable was EHCB. The implementation of incinerator technology was defined as an intervention activity consisting of demonstrations and hands-on practice in operating the incinerator, including waste sorting, charging the combustion chamber, the combustion process, and ash residue handling. Meanwhile, EHCB was defined as students' responses encompassing knowledge, attitudes, and practices related to waste management.

The research instrument consisted of a questionnaire using a four-point Likert scale, comprising 15 items covering three primary domains: knowledge, attitudes, and practices. The instrument's internal consistency yielded a Cronbach's alpha of 0.62. Although the internal consistency was within the acceptable range for exploratory studies, future research should refine the instrument to improve reliability and construct precision. Construct validity was established through expert judgment (content validity) and item-total correlation analysis, where all 15 items were found to be significantly correlated with the total score. The primary equipment was a campus mini-incinerator with a capacity of 10–15 kg, featuring a combustion temperature range of 600–900°C and equipped with a combustion chamber, chimney, automatic temperature control, and an ash residue container. Materials used included sorted dry waste such as paper and leaves, as well as safety equipment including masks and gloves.

Data collection was conducted in three stages: (1) a pretest to assess baseline EHCB, (2) an intervention consisting of weekly demonstrations and incinerator practice sessions lasting approximately 120 minutes each over a 16-week academic semester, and (3) a posttest to evaluate changes in EHCB following intervention. The intervention was designed as an initial trigger for behavioral awareness rather than a comprehensive behavioral modification program. Inferential analysis used the paired-sample t-test. To measure the magnitude of the intervention's impact, Cohen's d effect size was calculated and interpreted based on Cohen's criteria (0.2 = small, 0.5 = medium, 0.8 = large). Data were analyzed using descriptive and inferential statistics. A normality test was first conducted to determine the appropriate test of difference. If the data were normally distributed, a paired-sample t-test was applied; otherwise, the Wilcoxon signed-rank test was used. The results were presented in frequency distribution tables, supporting graphs, and statistical analysis tables accompanied by descriptive explanations of changes in students' behavior before and after the intervention.

3. RESULTS

3.1 The Characterustics of Respondents

The distribution of respondents' demographic characteristics is presented in Table 1. Based on Table 1, the total number of respondents in this study was 46. In terms of gender, the majority of respondents were female, totaling 40 individuals (86.96%), while male respondents accounted for 6 individuals (13.04%). This indicates that the sample in this study was predominantly female. With respect to age, most respondents were 22 years old, comprising 22 individuals (47.83%), whereas respondents aged 24 years represented the smallest group, with only 2 individuals (4.35%). Overall, the respondent characteristics in this study were dominated by females, with the most common age being 22 years.

Table 1. Respondents Demographic Characteristics

Parameter	Category	*f*	%
Gender	Male	6	13.04%
	Female	40	86.96%
Age (in years)	24	2	4.35%
	22	22	47.83%
	21	9	19.57%
	20	9	19.57%
	19	4	8.70%
Total		46	100%

3.2 Comparison EHCB Score

Table 2 presents the comparison of mean ECHB scores measured at the pretest and posttest stages following the incinerator practice intervention. Based on Table 2, the mean EHCB score increased by 7.20 points, representing a relative increase of 15.79%. Descriptively, students' EHCB achievement improved from the high category (76%) to the very high category (88%) following the incinerator practice intervention.

Table 2. Comparison Of EHCB Before and After The Intervention

Parameter	N	Mean	SD	Score	Mean↑	Mean (%)
Pretest	46	45.60	5.50	76.0%	7.20	15.79%
Posttest	46	52.80	4.50	88.0%		

3.3 Paired Sample t-test

Inferential analysis using a paired-sample t-test was performed to assess the effect of the intervention on students' EHCB scores, and the results are summarized in Table 3. Based on the results of the paired-sample t-test, a p-value of < 0.001 was obtained. Since this p-value is lower than the significance level of 0.05, the null hypothesis is rejected, indicating that students' EHCB scores differed significantly between the pre-intervention and post-intervention measurements.

Table 3. Result of Paired Sample t-test

Variables compared	Mean Difference (D)	95%CI	t	df	p-value	Cohen's d
Pretest-Posttest	-7.20	-8.90 to -5.50	-8.50	45	< 0.001	1.44

4. DISCUSSION

The The paired-sample t-test analysis yielded a p-value of < 0.001, indicating that the practical intervention involving the use of an incinerator was statistically effective and significant in improving students' EHCB (Mahesh et al., 2025). The calculation of Cohen's d resulted in a value of 1.44, which is categorized as a large effect (d > 0.8). This suggests that despite the relatively short duration of each session, the practical engagement provided a strong immediate stimulus to the students' responses. However, several limitations must be noted. The use of a pre-experimental design without a control group limits the ability to rule out external factors (e.g., prior knowledge or history) that might have influenced the posttest scores. Furthermore, while the 15.79% improvement is statistically significant, the marginal Cronbach's alpha (0.62) suggests that future studies should refine the instrument to enhance internal reliability. The study claims that the intervention helps bridge the "intention-action gap." Although separate subscale analysis for 'intention' versus 'action' was not formally conducted in this study, the descriptive increase in the psychomotor-related items suggests a shift toward practical competence. This study did not assess objective indicators such as waste volume reduction or long-term environmental sustainability outcomes. Therefore, the findings should be interpreted within the scope of short-term behavioral changes observed among students (Aubourg et al., 2023). Future research should employ a Randomized Controlled Trial (RCT) design and a longer follow-up period to evaluate the sustainability of this behavioral change over time (Remolina et al., 2025). The intervention helped bridge this gap by directly addressing the skills and behavioral components that often constitute weak points in behavioral measurement. The greatest improvement occurred in items measuring the psychomotor domain, indicating that hands-on experience successfully transformed theoretical understanding into practical competence.

In terms of strengthening self-efficacy through mastery experience, the practice and demonstration sessions using the incinerator provided students with direct mastery experiences (Hu et al., 2021). When students successfully operated the incinerator, sorted waste according to standards, and observed the waste reduction process functioning effectively, their confidence (self-efficacy) in managing waste responsibly increased (Wardani et al., 2025). Enhanced self-efficacy is a strong predictor that positive behaviors will be maintained. From the perspective of experiential learning, this intervention validates that educational models integrating theory with real-world practice-using the incinerator as a living laboratory-are more effective (Moore D. & Rhodes T, 2024). Such methods generate deeper understanding and reduce resistance to behavioral change compared with traditional lecture-based approaches.

The contribution of this intervention carries significant practical implications, particularly within the context of the waste emergency in the Special Region of Yogyakarta. The success of the UIMY intervention demonstrates that educational institutions can serve as pioneers in decentralized waste self-management. By training students, the campus effectively establishes an independent waste processing and management unit, supporting institutional waste management practice within the campus environment. This aligns with the demand for a paradigm shift in waste management practices (Sheriff

et al., 2025). In terms of health risk mitigation, the introduction and controlled practice of incinerator use provide critical education regarding the dangers of open burning practices that have become increasingly prevalent during the crisis (Kementerian Lingkungan Hidup dan Kehutanan RI, 2024). This intervention may contribute to increased awareness of environmental health risks at the institutional level. From an educational perspective, once students master this technology, they can serve as agents of change equipped with technical skills (Moore D. & Rhodes T, 2024). These skills are not only beneficial within the campus environment but can also be transferred to their communities, providing educational implications for decentralized waste awareness.

CONCLUSION

This study indicates that integrating incinerator technology into a practice-based learning approach is associated with improved students' EHCB in the short term. Framed as a technology-enhanced experiential learning model, the intervention supports behavioral engagement within an institutional context. However, due to the pre-experimental design and limited duration, the findings should be interpreted cautiously and confined to immediate behavioral outcomes rather than broader environmental sustainability impacts.

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Declaration of Generative AI

The authors declare that generative artificial intelligence tools were used in the preparation of this manuscript. ChatGPT (OpenAI) was utilized for language editing and grammar refinement, primarily to improve the quality of language in certain parts of the manuscript. The authors confirm that all outputs generated by artificial intelligence were carefully reviewed and edited by the authors. All research design, data collection, analysis, interpretation, and conclusions are entirely the authors' original work. The authors take full responsibility for the content of this manuscript.

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