

Shaping Future Minds: Exploring Basic Level Students' Attitudes towards Waste Segregation through Pre and Post-Test Intervention in Community School

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Abstract

Background: Waste management is an evolving public health concern in developing countries like Nepal, which perfectly aligns with environmental health function. Several factors such as low engagement of qualified professionals, limited financial allocation, and negligence of political commitment, low prioritization by policymakers have been attributed to this menace of importance of public health. This study explores basic-level students' attitudes toward waste segregation in Nepal.

Methods: Using a descriptive research design and proportionate random sampling, the study surveyed 200 students from public schools in Chitwan District, Nepal. Data was collected through a validated instrument and analyzed using SPSS 25 version. The frequency tables, percentages, and a t-test at a 0.05 significance level were calculated to examine the association of students' attitudes related to waste segregation before and after the Water, Sanitation, and Hygiene (WASH) program intervention.

Results: The intervention program significantly improved students' attitudes toward waste segregation, with positive attitudes rising from 17% to 74%. The proportion of students with low and moderate attitudes drastically decreased, demonstrating the program's effectiveness in promoting better waste management practices. Respondents' strongly agreement on the necessity of solid waste segregation increased from 40% to 70%, while positive attitudes toward ensuring a clean environment and efficient waste segregation practices also improved. The students' attitudes after program intervention showed significantly higher and more positive attitudes compared to the before intervention, supported by a p-value <0.01, confirming the positive impact of WASH

intervention to improve waste management efforts, it is advisable to expand and widely adopt similar initiatives, as they have demonstrated significant success in enhancing attitudes regarding waste segregation.

Keywords: Environmental education; sustainable development; waste management; waste segregation

Introduction

School waste is becoming a worsening issue, and the global annual school waste generation is expected to rise from the current 2.01 billion to 3.40 billion tons by 2050 AD. However, at least 33% of that is not currently managed in an environmentally safe manner (Kaza et al., 2022). Both developed and developing countries have taken measures to improve management by segregating and possibly recycling materials, saving land used in landfills, and improving environmental hygiene. Measures adopted include the provision of infrastructure and other technological and social measures to reduce generation and facilitate segregation and minimization. Both voluntary and compulsory separation of waste at source is effective, on different scales, at promoting management, recycling, and utilization of waste (Pires, 2011).

Well-organized, effective and efficient waste management is an essential part of sustainable development (Dada, et al., 2024; Morrissey & Browne, 2004). The saving of resources and energy is everyone's concern, and environmental education is vital to guarantee a sustainable lifestyle in the long run. In globe, a range of strategies to deal with waste are suggested and in utilization (European Commission, 2011; Pires, 2011). On the societal level: education, especially regarding awareness about environmental waste matters, is vital to achieve sustainable lifestyle.

Solid waste management is known as a core environmental health function, has persistently caused challenges to many policymakers, professionals, and societies in developing countries like Nepal. Several factors have been attributed to this menace of public health importance. These encompass a range of critical factors, including the insufficient engagement of qualified professionals such as environmental scientists, educators, environmental health officers, and environmental engineers in the process; prevailing human attitudes and behaviors towards solid waste management; inadequate financial allocation and resource mobilization for solid waste management programs; a shortage of adequately trained personal; a lack of political commitment and prioritization among policymakers; and a general disengagement or apathy among trained

professionals (Hangulu & Akintola, 2017).

These interrelated challenges hinder the effective implementation and sustainability of solid waste management initiatives. Waste segregation is the process by which waste is separated into different elements. The process occurs manually at the household and is collected through automatically separated materials recovery facilities or mechanical biological treatment systems. Hand sorting was the first method used in the history of waste segregation (Rani et al., 2022). The process further implies the grouping of waste into different categories, where it can be recovered, recycled, and reused. For appropriate segregation of waste, adequate knowledge and awareness is an essential aspect to those involved. Erhabor (2023) believes that a certain level of environmental education is an indispensable prerequisite towards the building and development of sufficient awareness of the relevance of segregation for appropriate waste management among students.

On a societal level, education about environmental waste matters is vital to help achieve a more sustainable lifestyle in the long run. The tertiary level of education is essential for education in general and environmental education in particular (Paudel et al., 2024). The knowledge and attitudes of students towards waste management, especially solid waste, are judged to be dependent on the level of environmental education accessible to them. To achieve substantial levels of separation of waste, it is essential to engage students, as they are the significant drivers of change and will have a major influence on the future of the world (Liao & Li, 2019). Human behavior is complex, and humans will change their behaviors when sufficiently enlightened. Waste segregation behavior can be defined as the behavior of separating waste according to the waste type in order to reduce the contamination of wastes which have potential value for recycling (Sin-Yee, & Sheau-Ting, 2016; Zsóka et al., 2013) think that education is a major factor in making young people aware of environmental problems, particularly their knowledge and attitudes towards solid waste management activities such as segregation and its importance and should be a vital part of their learning process. Hence, the knowledge gained from environmental education should be a major influence on attitudes and behavior towards environmental problems such as waste management and the relevance of segregation in the entire process. Students with adequate environmental knowledge and attitudes should be examined to understand their behavior and how to encourage waste separation and recycling at waste-generating sources. Most recyclers are more likely to get one or more sources of information, for example, friends, newspapers, and television.

Various sources of recycling knowledge coming from public education and information through public campaigns are expected to show a positive correlation with the recycling rate (Noh, 2024).

Attitude refers to how one thinks or feels about something or someone; it is a feeling or way of thinking that affects a person's behavior towards their feelings about recycling, as well as any preconceived ideas they may have towards it. According to nationwide studies in developing countries, many community members have a poor attitude towards solid waste management (Zambezi et al., 2021). Waste management is a critical environmental challenge in Nepal, yet there is limited research on the role of education in fostering sustainable waste segregation practices, particularly among basic-level school students. Existing studies on waste management in Nepal primarily focus on urban areas, technical solutions, and adult populations, leaving a significant gap in understanding how young students perceive and engage with waste segregation. Furthermore, there is a lack of data on the effectiveness of school-based environmental education programs in shaping students' knowledge, attitudes, and practices (KAP) toward waste segregation. This gap is particularly concerning given the potential of early education to instill lifelong sustainable habits and influence broader community behavior.

This study is highly relevant as it addresses these gaps by exploring the attitudes of basic-level school students, a demographic often overlooked in waste management research. By focusing on young learners, the study aims to highlight the role of schools as catalysts for environmental change. The findings will provide valuable insights for policymakers, educators, and environmental organizations to design targeted interventions that promote waste segregation from an early age. Additionally, the study contributes to global efforts to achieve Sustainable Development Goals (SDGs), particularly SDG 4 Quality Education (QA) and SDG 12 Responsible Consumption and Production (RCP), by emphasizing the importance of education in fostering sustainable practices. Ultimately, this research has the potential to shape future minds and create a generation of environmentally conscious citizens in Nepal.

Based on the Theory of Planned behavior (Ajzen, 1991) posits that attitudes significantly influence behavioral intentions, the following hypotheses were formulated:

H1: There is a significant difference in students' attitudes toward waste segregation before and after the WASH intervention.

H2: Students exposed to the WASH program will demonstrate significantly higher post-test

attitude than pre-test.

H3: Health and Environmental education on WASH component positively influences students' attitudes on waste segregation.

Theory of Planned Behavior (TPB)

The TPB has been widely used in research on pro-environmental behaviors, including many studies on waste separation. The TPB has also been applied to research on young people (Norman et al., 1998). Thus, relationships of attitudes in students before and after the WASH program intervention in students have been studied in various contexts. This work draws on this body of research and is based on hypotheses derived from the basic TPB model. Environmental attitude towards waste segregation is defined as a psychological tendency expressed by evaluating the natural environment with some degree of favor or disfavor. Do & Do, (2025) found that attitude is the strongest predictor of waste separation intention or behavior.

Research Methodology

The research design adopted for this study was the pre and post-test experimental design. It aimed at documenting a field survey of the impact of WASH program before and after the intervention relating to attitude of students on waste segregation. The instrument for this research consisted of a structured questionnaire. The instrument was constructed online with research objective, validated by the panel of three experts, and finalized addressing experts' feedback. The questionnaire was finalized after the pre-testing in the similar type of school, which consisted of the identical geography and grade level and were not included in the pre-and post-test evaluation.

Methods

The study is a part of a 5-year mixed-methods intervention project, which involves six public schools and three universities called Peer Resources. This study focuses on elective peer mentoring classes at these schools. PhD research fellows work as researchers, while students, teachers, and parents act as co-researchers, collaborating to coordinate Participatory Action Research (PAR) projects. These projects examine the practice and perception of the waste segregation program, with technical support from supervisors and the university team. The broader intervention aims to assess the impact of the PAR projects of WASH on basic-level students

(grades 4 - 8) at the institutional level.

This paper was constructed from a solely quantitative study by exploring how PAR intervention affects the overall school environment (Wilhelm et al., 2021). The PAR is an approach focused on collaboration and action within schools/communities to both understand and transform the world. This method involves actively addressing important issues by engaging participants as co-researchers. PAR emphasizes collective inquiry and action rooted in lived experiences (Chevalier, 2019). The present study was conducted in Nepal's community schools as part of the NORHED/*Rupantaran* project, employing the PAR approach in WASH to engage school families in improving school practices.

Intervention program of WASH

Initially, needs assessment, including pre-test was performed in a school located at Chitwan, Province 3, Nepal. Instantly after needs assessment/pre-test, intervention regarding the WASH program through PAR approach was initiated. In doing so, foremost, knowledge on waste segregation, ways of waste segregation such as disposal and non-disposal were provided to the students. The program further includes type of waste bin, handwashing stations with soap and other detergents, soap case, running water, menstrual pad management, irrigation matching, dance, drama, poems, storytelling, songs, sanitation campaign, video, conference, bridging workshop, participatory training, eco-plant, Eco-san toilet.

The study followed a three-cycle of PAR process, the first cycle involved initial field visits, needs assessments through pre-testing related to waste segregation. While the second cycle focused on school's WASH intervention through WSP teachers collaborated with researchers organized sensitization classes regarding WSP for basic level students ranging from grades 4 to 8, with 60-minute sessions per week. These activities encompassed scientific practices such as measuring food quality, the effects of Junk food on human health, food hygiene and source management for managing WSP. Through these hands-on activities, teachers aimed to connect the school curriculum with real-world scientific exploration, fostering collaborative learning among students, teachers, and parents. The third cycle, which is the subject of this paper, revolved around interventions based, integrating the active participation of schoolteachers, parents, and students.

Sample, Sampling, and Data Collection Procedure

In total, 200 structured surveys were administered in person from six public schools'

students studying grades 6 to 8 considers basic level in Nepal using a structured survey. The sample was calculated based on standard statistical formula for the infinite population $n = \frac{N}{1+N(e)^2}$ suggested by Sharma & Adhikari (2022; Sharma et al., 2024). Then, respondents were proportionally selected from each 6 selected public schools. Data was collected in person after getting approval from each participant using paper and pencil. Data were analyzed descriptively using SPSS 25 version; just two types of inferential statistics such as univariate and bivariate were applied in this research.

Ethical Considerations

The study proposal was reviewed and approved by the local Institute Review Board (IRB) that is Nepal Health Research Council (NHRC), approval number: 1960/2019. The ethical procedures involving human subjects were approved and thoroughly followed. The written consent was obtained from each participant prior to commencing the study. Since we have less than 18 years of respondents, we obtained consent from guardian as well as school administration to take interview with the students. They were informed that their voluntary participation will not provide any incentive for being participated on the study. During the interview and analysis, anonymity and confidentiality were maintained by using unique code and not disclosing responses shared by the respondents during the interview.

Materials and Methods

The study used a quantitative, cause-and-effect research design (Sharma et al., 2024). Specific questions were used to assess the participants' attitudes toward waste segregation. The attitude towards waste segregation questions was developed based on the attitude variable under the Theory of Planned Behavior (TPB). A total of six items were included in the test. A 4-point even Likert scale answer options which is maximally used in social science was used to measure respondents' attitudes regarding waste segregation. In the Even Likert type, the Likert question comprises 4-point answer options such as 1 Strongly Agree (SA), 2 Agree (A), 3 Disagree (D), and 4 Strongly Disagree (SD). The level of attitude on waste segregation was categorized based on the respondents' responses to Likert items. For instance, if the score ranges between 0 and 10, it consists of a low level of attitudes; a score of 11 to 15 indicates a moderate level of attitudes,

and 16 and above indicates a higher level of attitudes in both pre-and post-test evaluation.

Delimitation of the study

This study was delimited to:

- i. Six community schools in Chitwan district were selected as the study site.
- ii. Basic-level students (Grades 6-8) were the study participants.
- iii. Knowledge and practice-related components were analyzed
- iv. Quantitative data collected from the self-administered questionnaire was analyzed in the study
- v. The questionnaire was developed based on Theory of Planned Behavior (TPB).

Therefore, the findings cannot be generalized to all schools in Nepal without caution.

Results & Discussion

The result section considers three core thematic areas that include i) students' attitude levels in waste segregation, ii) students' attitudes towards waste segregation before and after implementation of the program, and iii) association of attitudes towards waste segregation before and after the WASH-related program under PAR approach.

Students' attitudes toward waste segregation

Table 1 depicts the attitude of waste segregation among students in pre and post-test evaluations. Students' attitudes of waste segregation significantly increased to 74%, which was just 17% before the program intervention. Simultaneously, students with low attitude levels in waste segregation drastically decreased to a minimal (2%) after the implementation of the program, which was one-third (34%) of the total before the implementation of the program. More importantly, students having a moderate-level attitude of waste segregation were reduced by half

(24%) in the post-test, which was 49% during the pre-test.

Table 1. *Students' attitudes in waste segregation during pre and posttest evaluation*

Attitudes level in waste segregation	Pre-test %	Pre-test %
Low	34	2
Moderate	49	24
High	17	74
Total	100	100

Students' attitudes towards waste segregation before and after implementation of the program

Table 2 explains attitudes of respondents before and after the program intervention towards waste segregation. Before the intervention, 40% of respondents strongly agreed and agreed that solid waste segregation at the source is necessary for solid waste management in the university community and outside. The agreed attitude was significantly increased at 70% and no response was revealed in disagree and strongly disagree after the intervention, which is the major indicator of programs efficiency in changing attitudes in waste segregation. Just under two-thirds (63%) agreed and 13% disagreed that they can guarantee a clean and healthy environment through solid waste segregation practices. The proportion that agreed was increased by 73% and disagreed proportion was decreased by 10% and reached 3% after the program intervention.

Meanwhile, 25% and 40% strongly agreed and agreed respectively that solid waste segregation at the source enhances waste minimization and resource maximization, the trend was slightly increased at 35% in strongly agreed and 47% in agreed after the program was implemented. In response to, segregation is very important in solid waste management, the proportion of strongly agreed and agreed has remained equal before and after the implementation of the project. I now ensure I can segregate my waste during deposit and for easy collection and management, 62% responded strongly agreed which was 10% higher than pre-test; the agreed proportion was identical in both pre-and post-test. In response to sorting garbage like scrap metals, plastics, papers, and organic waste during collection and before disposal, waste management has

become more efficient for me. A strongly agreed proportion was 20% higher after intervention than before intervention.

Table 2. *Students' attitudes towards waste segregation before and after implementation of the program*

Items to assess attitude level	Pre-test (%)				Post-test (%)			
	SA	A	D	SD	SA	A	D	SD
Solid waste segregation at the source is necessary for solid waste management in the university community and outside	40	40	16	4	30	70	-	-
Through solid waste segregation practices, I can guarantee a clean and healthy environment	24	63	13	-	24	73	3	-
Solid waste segregation at the source enhances waste minimization and resource maximization	25	40	20	15	35	47	12	-
Segregation is very important in solid waste management	36	60	4	8	36	60	44	-
From my knowledge in waste management, I now ensure that I segregate my waste during deposit and for easy collection and management	52	37	10	1	62	37	1	-
Sorting garbage e.g. scrap metals, plastics, papers, organic etc. during collection and before disposal has made waste management more efficient for me	46	32	12	10	66	32	2	-

Association of attitudes towards waste segregation before and after the WASH-related program

Table 3 explains the association of students' attitude after and before WASH program intervention regarding waste segregation. The attitudes of students were significantly associated with waste segregation, $p < 0.01$. The performance score for the experimental group, in terms of their attitudes toward the segregation process of solid waste management, is 17.78, while the performance score for the control group, in terms of their attitudes toward segregation, is 12.21.

This shows that there is a difference in the attitudes of waste segregation between the experimental and control groups. That is, environmental education has an effect on the attitudes of waste segregation, especially given the fact that the experimental group had a higher mean on their knowledge of waste segregation than the control group.

In the same way, the students' attitudes were perfectly associated towards waste segregation, $p < 0.01$. The performance score for the experimental group in terms of attitude towards waste segregation is 21.00, while that of the control group is 17.30. Moreover, it can be seen in the table that the t-value is 8.94 and the level of significance is 0.00, which is less than the set alpha level of 0.05. This shows that there is a significant difference in the attitude towards waste segregation between the experimental and control group. That is, environmental education has an effect on the attitude towards waste segregation, with the environmental education students having a more favorable attitude.

Table 3. Association between the experimental and control group students' attitude during pre and posttest on waste segregation

Group	Pre-Mean	Post Mean	Std. Deviation	t-value	Sig.
Pre-test attitude**					
Experimental	11.24	17.78	1.31487	16.78	0.00
Control	10.98	12.21	2.09617		
Post-test attitudes **					
Experimental	14.24	21.30	2.72475	8.94	0.00
Control	13.83	17.30	3.54908		

Note: Statistically significant at ** = $p < 0.01$

Finally, the findings reveal:

- i. A statistically significant improvement in students' attitudes toward waste segregation following the WASH intervention ($p < 0.01$), supporting H1.
- ii. The experimental group demonstrated significantly higher post-test mean scores than the control group, supporting H2.
- iii. Health and Environmental Education positively influenced attitudinal change, Confirming H3.

The increase from 17% in high level attitudes demonstrates the effectiveness of structured WASH-

based environmental education.

Discussion

Present study found that the attitude of waste segregation among students was drastically increased to 74% after the project intervention, which was just 17% during non-intervention. The findings are identical to Acharya (2018) who reported low level of knowledge and attitudes among students; however, author did not mention that, whether the evaluation was before and after the intervention, which looks like just cross-sectional study. Another study revealed that of the total, 73.4% of the students indicated their attitudes to be satisfactory towards waste management.

This study further highlighted that there is significant difference in attitudes between before and after the project intervention towards waste segregation. Identical with our findings, waste segregation between the experimental and control groups showed that there is a significant difference in the attitude of waste segregation between the experimental and control groups. This indicates that WASH intervention has an impact on the attitudes of waste segregation among students (Erhabor, 2023; Erhabor & Don, 2016). Authors further highlighted that environmentally literate students, especially in tertiary institutions, are being nurtured to foster environmental education in Nigeria.

Comparing data analyzed from the two groups on respondents' opinions on the impact of WASH program on students' attitudes towards waste segregation shows some differences in areas such as the relevance of waste segregation in solid waste management. Here, almost all respondents of the experimental group agreed, whereas 80% of the control group agreed and 20% disagreed. Also, 82% of the experimental group agreed that solid waste segregation at source enhances waste minimization and resource maximization, compared to 65% of the control group. Comparing this to literature findings, the study showed that there is a significant difference in the attitude towards waste segregation between the experimental and control groups. That is, WASH program affects the attitude towards waste segregation, with environmental education students having a more favourable attitude. Sapanova et al. (2024) stated that environmental education strongly influences environmental attitudes in students, and the basic aim of environmental education is to induce pro-environmental intention and behaviour. However, recent studies showed that it is more important to acquire environmental attitudes than just achievement in behavior, which was by the disclosure of UNESCO 1978. It is generally recognized that environmental

education and related programs influence environmental knowledge, especially in the case of young students. The intensity of students' environmental education strongly influences their environmental knowledge, attitudes, and practices Sapanova et al., (2024) as found in this study.

The findings of this study strongly support the assumptions of the TPB, which posits that attitude significantly influences behavioural intention and action (Ajzen, 1991). According to TPB, a positive shift in attitude increases the likelihood of pro-environmental behavior. The significant improvement from 17% to 74 % in high-level attitudes indicates that the WASH intervention successfully influenced students' attitudinal components, a key determinant of behavioural intention.

The statistically significant difference ($p < 0.01$) between pre- and post-scores confirms H1, indicating that Environment and Health Education as interventional activities has measurable impact on attitude information. Furthermore, the higher mean scores in the experimental group compared to the control group confirm H2, suggesting that exposure to participatory WASH activities positively influences students' evaluation beliefs about waste segregation.

Within the TPB framework, attitude reflects students' favorable or unfavorable evaluation of waste segregation practices. The increased agreement levels on statements such as "solid waste segregation enhances resource maximization" demonstrate strengthened behavioural beliefs, which are central constructs in TPB.

The result also aligns with Do & Do (2025), who found that attitude is the strongest predictor of waste segregation intention. Similarly, Sapanova et al. (2024) highlighted that environmental education significantly shapes environmental attitudes following educational interventions.

Thus, H3, accepted as environmental education under the WASH-PAR model, significantly influenced students' attitudes toward waste segregation.

The participatory nature of the intervention likely strengthened subjective norms and perceived behavioural control, additional constructs of TPB, although these were not directly measured in

this study. Future research may incorporate these components for comprehensive TPB modeling.

Limitations of the Study

Despite its contributions, the study has several limitations:

- i. Only attitude was examined; behavior was not directly measured.
- ii. Self-reported data may contain social desirability bias.
- iii. TPB constructs such as subjective norms and perceived behavioural control were not directly analyzed.
- iv. The intervention duration may not reflect long term sustainability of attitude change.

Future research should adopt longitudinal designs and include behavioural measures to validate sustained impact.

Conclusion

The program intervention significantly improved students' attitudes toward waste segregation, with a notable increase from 17% to 74% in positive attitudes. Besides, the proportion of students with low and moderate attitudes drastically decreased, highlighting the program's effectiveness in fostering better attitudes in waste management. The program intervention significantly improved respondents' attitudes towards waste segregation, with a notable increase in agreement from 40% to 70% on the necessity of solid waste segregation for effective waste management. Positive attitudes towards ensuring a clean environment and the efficiency of waste segregation practices also rose, while disagreement levels dropped, indicating the program's effectiveness. In a similar vein, stronger agreement was observed in responses related to waste minimization, resource maximization, and the importance of sorting waste, further demonstrating the program's success in fostering better waste management practices. The experimental group demonstrated significantly higher attitudes and more positive attitudes towards waste segregation compared to the control group, with performance scores of 17.78 and 21.00, respectively. These findings, supported by a p-value <0.01 , highlighted the positive impact of WASH program under PAR approach on improving attitudes related to waste segregation.

The WASH intervention significantly improved students' attitudes toward waste

segregation, with high-level attitudes increasing from 17% to 74%. Statistical evidence ($p < 0.01$) confirms the effectiveness of environmental education in shaping pro- environmental attitudes.

Grounded in the TPB, the study demonstrates that educational interventions positively influence attitudinal components, which is a critical predictor of behavioural intentions. The experimental group consistently outperformed the control group, highlighting the importance of structured, participatory environmental programs.

However, due to geographical and methodological limitations, findings should be interpreted cautiously. Expanding similar interventions across diverse regions and integrating behavioural measurements would further strengthen environmental education research.

It is recommended to expand and implement similar WASH programs widely, as they have proven effective in significantly improving attitudes related to waste segregation among students.

Educational Implications

The findings have important implications:

- i. Schools can serve as transformative spaces for environmental behavior change.
- ii. Integrating WASH modules into curriculum may strengthen sustainable habits.
- iii. PAR enhances ownership and engagement
- iv. Teacher training programs should incorporate environmental education.
- v. Policy-level integration can support SDG 4 and SDG 12.

Early environmental education can cultivate lifelong, sustainable citizens and influence community-level environmental practices.

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Disclosure Statement

No potential conflict of interest was reported by the author.

Ethical Statement

This research was conducted according to the guidelines laid down in the Declaration of Nepal Health Research Council (NHRC) and the Nepal Government and all procedures involving human subjects were approved by the Ethics Committee of the NHRC. Consents were obtained from all the research participants.

Authors' Contributions

GPD collected, transcribed, translated and interpreted the data, and drafted the manuscript. MKS and TRK provided scholarly guidance and corrected the manuscript. All the authors read and approved the final version of the manuscript.

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