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**Original Research Article**

# Immediate effects of a one-day educational intervention on food waste awareness and resource recovery knowledge among school students in Bintulu, Sarawak

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**ABSTRACT**
Malaysia generates approximately 8.3 million metric tons of food waste annually, accounting for more than 44% of municipal solid waste. Educational intervention at school level may help address this issue by improving early awareness and knowledge related to food waste reduction and resource recovery. This study evaluated the immediate effects of a one-day educational intervention among school students in Bintulu, Sarawak. A quasi-experimental pre-test and post-test design was used involving 87 students, comprising 48 primary school students and 39 secondary school students. The intervention included seminar sessions, small group discussions, and a technology demonstration using a food waste composting prototype. Immediate post-intervention results showed improvement across all measured domains. Sustainable awareness recorded the largest gains in both groups, with large effect sizes observed among primary students ($d$ = 2.04; 89.9%) and secondary students ($d$ = 2.00; 128.3%). Primary students also showed marked improvement in recycling knowledge (123.8%), while secondary students improved in food waste knowledge (26.0%) and recycling knowledge (29.3%). These findings indicate that a short, multi modal intervention can generate substantial immediate learning gains among school students. However, the absence of a control group and the same-day assessment design mean that the findings should be interpreted as short term educational effects rather than evidence of sustained behavioural change. Longer-term follow-up is needed to determine whether these gains are retained and translated into practice.

## 1. Introduction

Food waste is a growing environmental and management challenge in Malaysia. The country generates approximately 8.3 million metric tons of food waste annually, representing more than 44% of total municipal solid waste, or about 17,000 tonnes per day [1]. This high proportion places considerable pressure on waste handling systems and landfill capacity. In Bintulu, Sarawak, continued urban growth has further intensified demands on local waste management infrastructure [2].

Although public concern about food waste has increased, awareness alone does not necessarily lead to sustained behaviour change. More than half of Malaysians are reported to waste food daily, suggesting a persistent gap between what people know and what they actually do. This pattern is consistent with the broader knowledge action gap described in environmental behaviour research, where awareness does not automatically translate into responsible practice [3].

School-based educational intervention provides an opportunity to address this issue at an early stage. Students are at a formative phase of behavioural development, and targeted exposure to practical sustainability concepts may help strengthen both understanding and future action. Educational research has shown that participatory and experiential approaches generally produce stronger engagement and learning outcomes than passive instruction alone [4, 5]. In the context of food waste, this is especially relevant because the topic involves not only factual knowledge, but also attitudes, habits, and everyday decision-making.

This study, therefore, examined the immediate effects of a one-day educational intervention on food waste awareness and

resource recovery knowledge among primary and secondary school students in Bintulu, Sarawak. The study focused specifically on short term changes between pre-intervention and post intervention responses.

## 2. Methodology

### *2.1 Study design and participants*

A quasi-experimental pre-test and post-test design was used to evaluate the immediate effects of the intervention. Both assessments were administered on the same day, before and immediately after programme completion. The study involved 87 students from schools in Bintulu, comprising 48 primary school students aged 10 to 12 years and 39 secondary school students aged 14 to 19 years. No control group was included.

### *2.2 Intervention components*

The one-day intervention was designed as a multi modal educational programme consisting of seminar sessions, small group discussions, and a technology demonstration. The seminar sessions introduced students to the environmental impacts of food waste and the concept of resource recovery using age-appropriate presentations. The small group discussions encouraged peer interaction, reflection, and critical thinking. The technology demonstration provided hands-on exposure to a food waste composting prototype, allowing students to observe a practical example of waste valorisation.

**Table 1:** Intervention components and designed activities.

| Components | Activities |
|---|---|
| Seminar sessions | Age-appropriate presentations on food waste impacts and resource recovery |
| Small-group discussions | Facilitated peer interaction and critical thinking activities |
| Technology demonstration | Hands-on exposure to a food waste composting prototype |

### *2.3 Measures and analysis*

Age-appropriate questionnaires were developed separately for primary and secondary school students. Both questionnaires assessed sustainable awareness and recycling knowledge. The secondary school questionnaire additionally assessed food waste knowledge. This structure was intended to reflect differences in cognitive level and content suitability across age groups.

Pre-intervention and post-intervention scores were compared using paired sample analyses. Mean increase and percentage improvement were calculated to describe the magnitude of change. Effect sizes were interpreted using Cohen's *d*, where 0.2 indicates a small effect, 0.5 a medium effect, and 0.8 a large effect [7].

## 3. Results

The intervention produced immediate improvements across all measured domains in both groups. Figure 1 and Figure 2 summarise key outcomes.

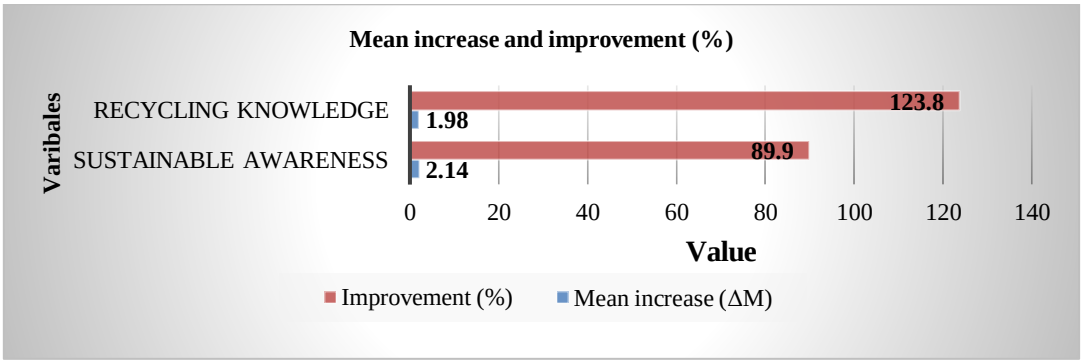


**Figure 1:** Changes in sustainable awareness and recycling knowledge among primary school students following the intervention. Large effect sizes were observed for both variables.

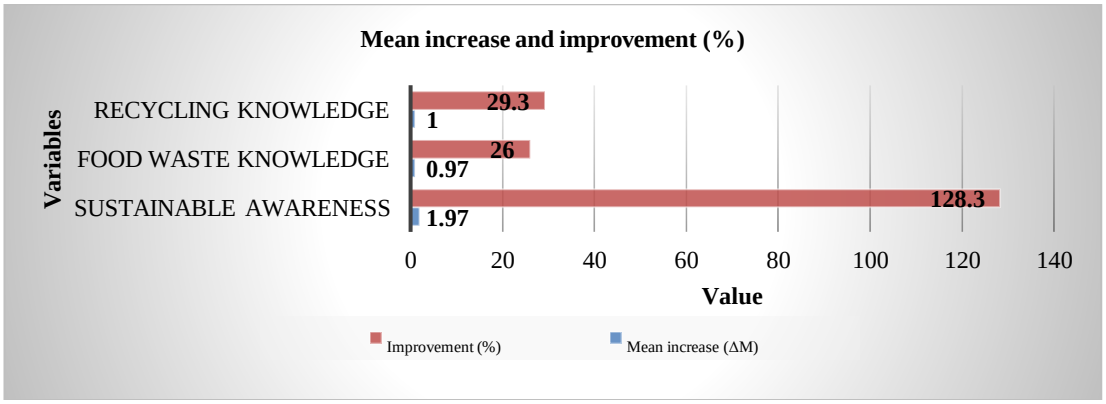


**Figure 2:** Effect sizes for sustainable awareness, food waste knowledge, and recycling knowledge among secondary school students following the intervention.

Among primary school students, sustainable awareness increased by a mean of 2.14 points, representing an improvement of 89.9%, with a large effect size ($d$ = 2.04). Recycling knowledge also increased substantially, with a mean gain of 1.98 points and an improvement of 123.8%. These results indicate that the intervention was highly effective in improving immediate understanding among younger participants, particularly for more concrete and practice-oriented concepts.

Among secondary school students, sustainable awareness again showed the largest improvement, with a mean gain of 1.97 points, an improvement of 128.3%, and a large effect size ($d$ = 2.00). Food waste knowledge increased by 0.97 points, corresponding to an improvement of 26.0%, while recycling knowledge increased by 1.00 points, corresponding to an improvement of 29.3%. According to the study results, all measured outcomes fell within the large effect range.

Overall, the findings show that the one-day intervention was associated with substantial short-term learning gains in both groups, although the pattern of improvement differed slightly by school level. Primary school students showed stronger gains in recycling knowledge, whereas secondary school students showed the strongest gains in sustainable awareness.

## 4. Discussion

The findings indicate that the one-day educational intervention produced strong immediate gains in awareness and knowledge related to food waste and resource recovery among school students in Bintulu. Sustainable awareness showed the largest improvement in both primary and secondary groups, with effect sizes well above the threshold commonly interpreted as large. This suggests that the intervention was effective in delivering short term educational impact within a limited time frame.

One likely reason for this strong response is the structure of the programme itself. Rather than relying only on lecture-based delivery, the intervention combined seminar input, peer discussion, and direct exposure to a practical composting technology. This kind of multi modal format is consistent with broader educational evidence showing that participatory and active learning approaches tend to strengthen student engagement and understanding more effectively than passive instruction alone [4, 5]. For a topic such as food waste, which connects environmental knowledge with daily behaviour, this kind of practical and discussion-based approach is especially relevant.

The results also suggest some age-related differences in how students responded to the intervention. Primary school students showed particularly strong improvement in recycling knowledge, while secondary school students demonstrated the greatest gains in sustainable awareness. This pattern is plausible. Younger students may respond more strongly to concrete and visible practices, such as waste separation or composting demonstration, while older students may be better able to engage with broader environmental concepts and system level implications. This supports the idea that educational content should be calibrated according to developmental level rather than delivered in a uniform way across age groups.

That said, the findings should not be overstated. The study measured immediate post-intervention responses only, so it cannot determine whether the observed gains were retained over time or translated into real behavioural change. This matter because environmental education often improves awareness more easily than practice. The knowledge-action gap remains a major issue in sustainability work, and increased understanding immediately after a programme does not prove lasting impact [3].

In addition, the absence of a control group limits causal interpretation. It is reasonable to conclude that the intervention was associated with improved scores, but it is not methodologically defensible to claim a definitive causal effect without comparison against a non-intervention group. The present findings are therefore best understood as evidence of strong short-term educational gains following programme participation.

## 5. Limitations

This study has several limitations that should be acknowledged. First, no control group was included, which limits causal attribution. Second, the pretest and posttest were conducted on the same day, meaning the study only captured immediate learning gains and not longer-term retention. Third, the sample size was relatively small and drawn from a single local context, which restricts generalisability beyond the study setting. Finally, the use of self-reported questionnaire responses means that the results reflect perceived awareness and knowledge rather than observed behavioural change. A longer-term follow-up, such as a three-month assessment, would strengthen the study by examining whether the gains are maintained and reflected in practice.

## 6. Conclusions

A one-day multi modal educational intervention produced clear immediate improvements in food waste related awareness and knowledge among primary and secondary school students in Bintulu, Sarawak. Sustainable awareness showed the strongest gains in both groups, while knowledge-based outcomes also improved following participation. The findings support the value of short, structured, and practical educational interventions in raising student understanding of food waste reduction and resource recovery. However, the study does not yet demonstrate lasting behavioural change. Future work should include longer-term follow-up and appropriate control conditions to determine whether these short-term gains are retained and translated into sustained action.

## Authors' contributions

All authors contributed equally to the conception, design, data analysis, interpretation of results, and preparation of the manuscript. All authors reviewed and approved the final version of the manuscript for publication.

## Conflicts of interest

The author declares no conflict of interest.

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## Data availability

No new data were created.

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