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Profiling Vocational Students' Sustainability Literacy in the Skills Domain of Food Waste Education

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Abstract. Food waste poses a serious environmental challenge that requires not only conceptual awareness but also practical sustainability competencies. This study aims to profile vocational high school students' sustainability literacy in the skills domain of food waste education as a preliminary step toward developing interactive learning media. A total of 36 Grade X students in Bogor participated in a field trial using a prototype e-book entitled *Awas Food Waste*. Students were assigned to solve a contextual case, design digital posters, and present their solutions in class. Poster texts (365 words) were analyzed through word-frequency techniques, while oral presentations were assessed using a rubric adapted from Murray and Cotgrave. Results showed that frequently used terms indicated both problem recognition (e.g., sisamakanan [food leftovers], food waste, sampah [waste]) and proposed solutions (e.g., kompos [compost], maggot, organik [organic]). The presentation scores averaged 3.53 (median = 3; mode = 3), categorized as "sufficient–good," with 22.2% of students achieving a very good level. These findings reveal that students are able to identify and communicate practical strategies to reduce food waste, although the depth and innovation of solutions remain limited. The study highlights a gap between awareness and applied action, underscoring the importance of scaffolding through interactive e-books and other digital media. This preliminary evidence serves as a baseline for designing pedagogically grounded interventions to strengthen vocational students' sustainability skills and foster responsible environmental behavior.
Keywords: Sustainability literacy; food waste; vocational education; skills domain; interactive e-book

Introduction

Food waste contributes significantly to ecological damage. Food waste leaves an invisible carbon footprint. It accounts for nearly 10% of total global greenhouse gas emissions, positioning it as one of the major contributors to the acceleration of climate change (FAO, 2017). Food wasting behavior refers to consumable food that is discarded or damaged by consumers, eventually ending up as waste (Radde et al., 2024). There is a significant gap in understanding the implications of waste in developing countries (Parfitt et al., 2010). This reflects a fragile culture of sustainable consumption and a low level of

sustainability literacy, particularly regarding awareness of the environmental consequences of food waste (Elzagi et al., 2023).

Food waste represents a key sustainability challenge that can be mitigated through sustainability-oriented education, redistribution of surplus products, supply chain governance strategies, and environmentally responsible management of food resources (Manzoor et al., 2024). As such, food waste is not only a socio environmental problem but also a pressing educational issue. Due to its significant environmental, social, and economic impact, food waste has recently attracted the attention of many institutions and become the subject of numerous studies (Antón-Peset et al., 2021).

Researchers are paying more attention to how younger generations handle their food waste in light of the global issues around food waste (Martin-Rios et al., 2025). Relevant research on consumers and food waste among school-aged children is even rarer (Panatsa and Malandrakis, 2024). Current research on food waste predominantly focuses on measurement, logistics, and technical management. Comparatively few studies examine how education influences individual awareness and behavior (Piras et al., 2023). Education remains a powerful tool in shaping environmental consciousness (Malefors et al., 2024). Contextualized environmental education has been shown to be effective in fostering ecological awareness, particularly when implemented during school years (Tilbury, 2011). It is important to integrate comprehensive sustainability education and practical initiatives into teaching programs to turn intentions into actions.

The recent development must undergo changes to align with the aims of sustainable development (Korte et al., 2023), as outlined by the achieving the SDGs promotes the necessary transition toward a more sustainable society. (Kioupi & Voulvoulis, 2022). Within this framework, sustainability literacy encompasses the interrelated dimensions of knowledge, skills, and values (Murray & Cotgrave, 2007). The study confirms that education with basic knowledge, skills, and attitudes/behaviors is key to developing sustainable food literacy competencies (McManus et al., 2025). The academic environment also plays a strategic role in building these competencies (Prada et al., 2020).

Technological advances have introduced innovative approaches to delivering sustainability education (Blewitt & Cullingford, 2004). In this context, the development of sustainability literacy is very important (Chinedu et al., 2023). Interactive and digital learning tools, such as e-books that combine visuals, text, and animation, can increase student engagement (Witabora, 2012). Digital media provide opportunities to strengthen sustainability literacy by facilitating a more flexible and independent learning environment (Warliyah et al., 2023).

Despite this potential, food waste education still lacks integrated media that contextualize learning with students' real-life behavior. This is particularly true for approaches that assess student literacy holistically across domains and educational levels. In practice, many educational efforts remain information-driven and fail to engage students holistically across cognitive, behavioral, and affective domains (Pandey et al., 2023). Moreover, few studies in Indonesia specifically address how students differ in their sustainability literacy profiles, especially in terms of knowledge, skill, and value alignment (Saputra et al., 2024).

In the context of educational innovation, a preliminary study is essential not only to map students' sustainability literacy but also to inform the development of relevant learning media. The present research positions itself as a foundational step for designing an interactive e-book on food waste. The development of picture storybook media is appropriate for students (Mulyoto et al., 2023). By analysing students' knowledge, values, and practical skills including the artefacts they produced through digital posters. This study provides empirical evidence of learners' needs, misconceptions, and strengths.

Studies have shown that students' critical thinking regarding environmental issues in Indonesia are still relatively low (Pinareswati et al., 2025). This highlights the importance

of developing interactive, value-driven educational media, such as e-books, which have the potential to enhance students' environmental literacy and foster sustainable behavior (Rachman & Septiana, 2020). Effectively developed science e-books can improve students' creative problem solving (Rohmah et al., 2025). The present research demonstrates how students are able to exhibit practical competencies through authentic tasks, such as designing digital posters and presenting their proposed solutions. Previous studies have also shown that multimedia integrated with character animation can improve students' sustainability literacy (Rahmadani et al., 2025).

Moreover, reducing food waste is particularly urgent in middle-income countries with high rates of undernourishment (Jayadevan, 2022). Which reinforces the importance of equipping students with actionable skills that connect awareness to real world solutions. This skills-oriented approach aims to reveal deeper patterns of students' ability to translate sustainability concepts into practice patterns that may not be captured through descriptive knowledge-based comparisons alone. The findings are expected to inform future educational strategies, particularly the design of interactive learning media that strengthen vocational students' sustainability skills and foster environmentally responsible behavior.

Methods

This study employed a descriptive approach to profile students' sustainability literacy in the skills domain. Unlike the previous preliminary survey that examined knowledge, skills, and values through a questionnaire, this phase specifically focused on practical competencies as demonstrated through digital artefacts and oral presentations. The participants were 36 purposively selected vocational high school students from grade X in Bogor City. Students accessed a prototype of an interactive e-book (see Figure 1).

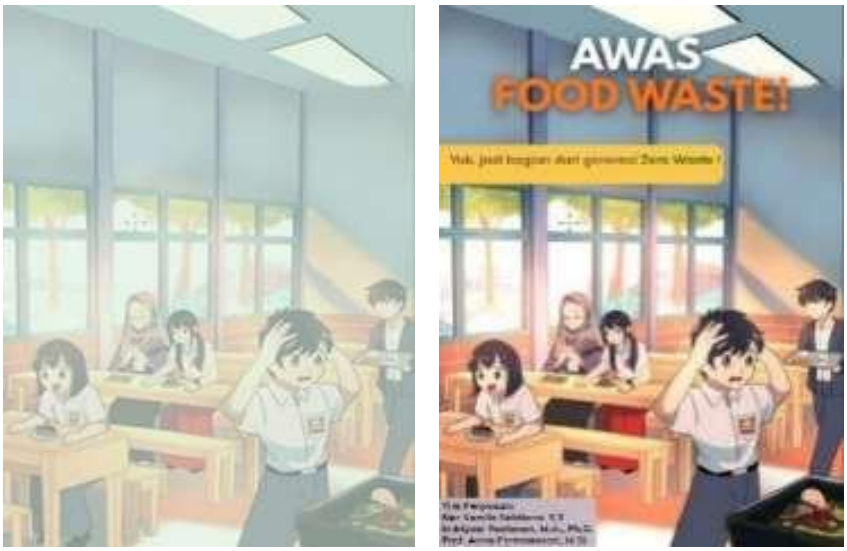

Figure 1. Cover e-book

The e-book was designed to raise awareness of food waste and provide structured learning activities. Students were instructed to open the e-book via the link provided, explore the content, and complete *case study* 1, which presented a contextual problem related to food waste management. As a follow-up, they created digital posters proposing solutions to the case and presented their ideas to their peers. This activity engaged

students in using digital media and provided authentic artefacts for assessing their sustainability skills.

Two main instruments were used in this study: (1) digital posters, in which students created posters addressing the problem of food waste and proposed practical solutions. The poster texts were compiled into a corpus of 365 words for frequency analysis; and (2) a presentation rubric adapted from Murray & Cotgrave, focusing on the indicator "use of tools, objects, and procedures that align with sustainability." Scores were assigned on a 1–5 scale (1 = very poor, 5 = excellent).

The poster corpus was analysed using word-frequency techniques and visualised in a word cloud, with results summarised in tables. Presentation scores were analysed using descriptive statistics (mean, median, mode, frequency distribution to determine the overall profile of students' sustainability skills. Triangulation of poster content and rubric scores provided a comprehensive picture of students' applied literacy in the skills domain. The resulting corpus was visualised using a word cloud and summarised in tables. Presentation scores were analysed using descriptive statistics (mean, median, mode, frequency distribution) to determine the overall profile of students' sustainability skills. The triangulation of poster content and rubric scores provided a comprehensive picture of students' applied literacy in the skills.

Results and Discussion

The results of the sustainability literacy assessment are presented in the skills domain, focusing on one key indicator: the use of tools, objects, and work procedures aligned with sustainability, such as selecting environmentally friendly equipment. Students were tasked with creating digital posters proposing solutions to case study 1 in the food waste e-book.

To provide a more systematic overview of students' performance, the textual content of all 36 posters was first compiled and tabulated before visualisation. Each poster represented an individual student's response to the case study, which required identifying the causes of food waste and proposing feasible solutions. This process ensured transparency of the raw data and allowed for a clearer view of the diversity of students' ideas.

Table 1 presents the compilation of students' poster texts, which were subsequently processed for frequency analysis. By displaying the original entries, the table highlights recurring terms and expressions, serving as the basis for identifying dominant themes prior to the wordcloud visualisation. This step strengthens the credibility of the analysis by showing how the final word-frequency results were derived from authentic student artefacts.

Table 1. Collection of student posters on food waste (N = 36)

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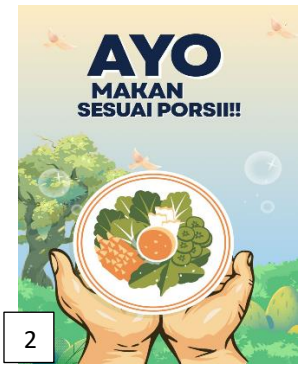

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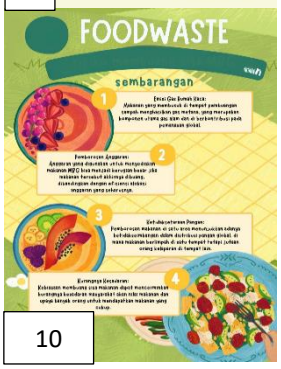

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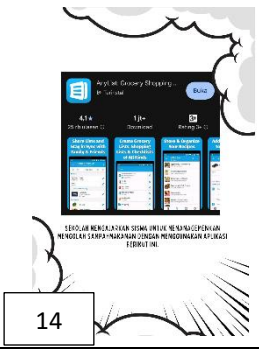
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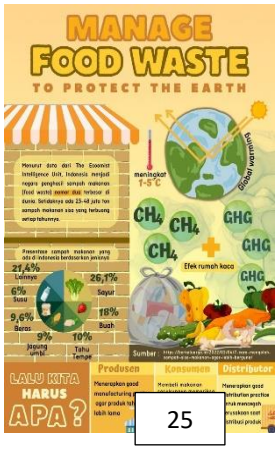

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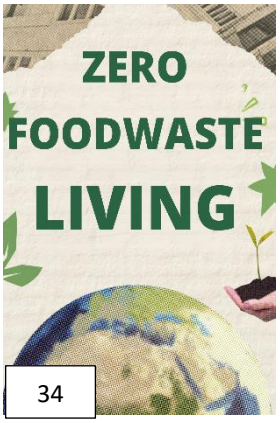

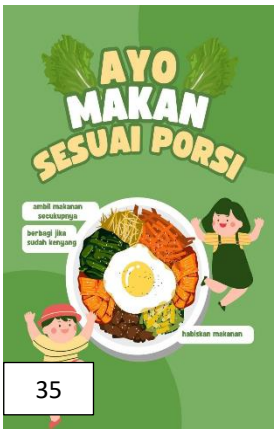

After compiling the 36 student posters into a single dataset, the textual content was analysed using word-frequency techniques to capture recurring terms. The analysis was then visualised in the form of a word cloud, where words that appeared more frequently were displayed in larger font sizes. This visualisation provides an intuitive overview of students' dominant ideas regarding food waste and its solutions. The results of the analysis are presented in Figure 2.

Figure 2. Student skills analysis results

Figure 2 illustrates that the most frequently occurring words in students' posters are closely related to waste, compost, environment, and food residues (sisamakanan), indicating that most students already possess a basic awareness of food waste issues and sustainability practices in organic waste management. Terms such as *kompos* (compost), *organik* (organic), *maggot*, and lingkungan (environment) highlight students' consideration of practical solutions, although the level of sophistication remains limited. Action-oriented expressions such as *mengurangi* (reduce), *selamatkan* (save), and *caramengatasi* (ways to overcome) further suggest that students not only recognize food waste as a problem but also attempt to frame it within a solution-oriented narrative. Nevertheless, these solutions tend to remain relatively simple such as composting or basic organic waste management and may lack more innovative or technically advanced approaches.

Therefore, the *wordcloud* serves as an indicator that students' skills domain already encompasses both problem recognition and practical solution framing, which provides a crucial baseline for designing educational media. Such media should not only enhance students' conceptual knowledge but also strengthen their ability to develop more mature, innovative, and sustainable solutions. To examine students' sustainability skills, the digital posters produced during *case study* 1 were analysed through word frequency counts. A total of 365 words were identified across all posters. The frequency distribution highlights both problem recognition (e.g., *sisamakanan*, *foodwaste*, *sampah)* and solution-oriented concepts (e.g., *kompos, maggot, organik*). Motivational words such as *selamatkan* and *ayo* also appeared, suggesting that students not only recognised food waste as an issue but also framed it as a call to action. The percentage of occurrence for the most salient words is presented in Table 2.

Table 2. Percentage of words in a poster

The Number	Word	Words in a Poster (%)
39	*Sisamakanan*	5.26
30	*foodwaste*	4.05
16	*sampah*	2.16
13	*mengurangipencemaran*	1.75
12	*lingkungan*	1.62
12	*sisa*	1.62
10	*kompos*	1.35
10	*selamatkan*	1.35
9	*mbg*	1.21
8	*caramengatasi*	1.08
7	*makan*	0.94
7	*mencegah*	0.94
6	*bergizi*	0.81
5	*ayo*	0.67
5	*dampak*	0.67
5	*maggot*	0.67
5	*membuang*	0.67

5	*menjaga*	0.67
5	pemborosan	0.67
5	sumberdaya	0.67
5	*waste*	0.67
4	*air*	0.54
4	*alam*	0.54
4	*edukasi*	0.54
4	*gratis*	0.54
4	*habiskan*	0.54

A total of 365 words were collected from students' posters and analysed using word-frequency techniques. The most frequently used terms were *sisamakanan* (food leftovers, 5.26%) and food waste (4.05%), followed by *sampah* (waste, 2.16%), *mengurangipencemaran* (reduce pollution, 1.75%), and *lingkungan* (environment, 1.62%). Solution-oriented expressions also appeared consistently, such as *kompos* (compost, 1.35%), *maggot* (0.67%), and *organik* (organic, 0.54%). In addition, students connected their ideas to national programs, such as free nutritious meals program, and employed motivational words like *selamatkan* (save) and *ayo* (let's). These findings indicate that the posters not only demonstrated students' awareness of food waste issues but also reflected calls to action and the formulation of contextual solutions.

To provide a clearer visualisation of the frequency distribution, the percentage of word occurrences was also presented in a bar chart. As shown in Figure 3, *sisamakanan* and food waste emerged as the most salient terms, followed by *sampah*, mengurangipencemaran, and lingkungan. The chart illustrates a clear distinction between words associated with problem identification (e.g., *sisamakanan, sampah*) and those related to proposed solutions (e.g., *kompos, maggot, organik*). This visual representation reinforces the conclusion that students were not only aware of food waste as an environmental issue but had also begun to formulate concrete actions for its reduction.

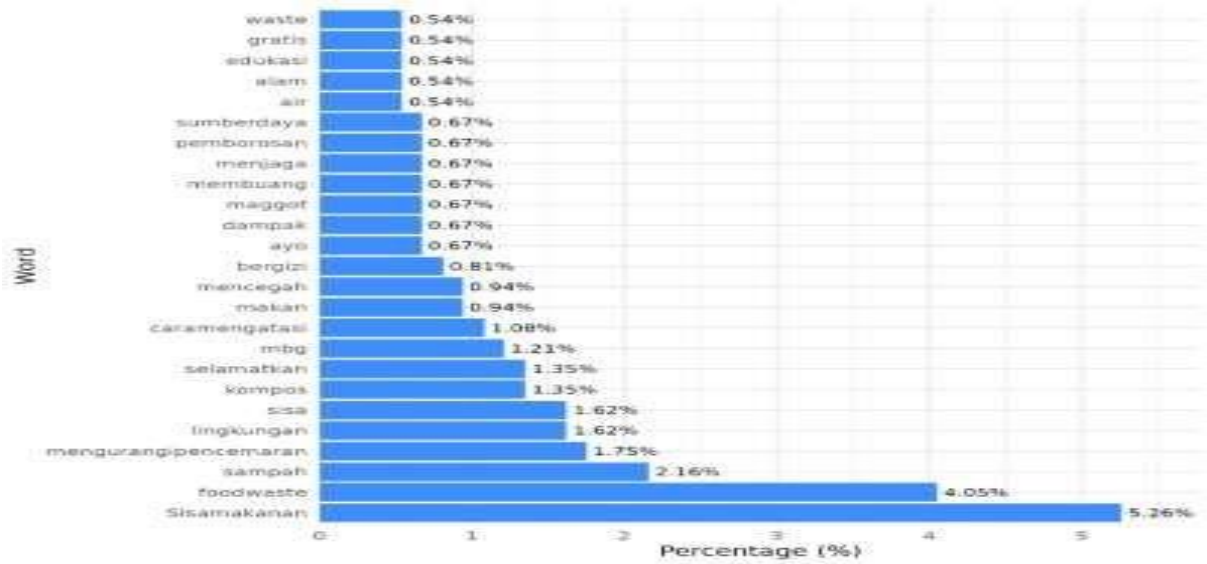

Figure 3. Percentage of words in a poster

In addition to analyzing keywords on students' posters through word clouds, this study also assessed students' ability to convey ideas and concepts through classroom presentations. The following is the rubric used for presentation assessment in Table 3.

Table 3. Skills assessment section

Score	Assessment Description
1	Unable to relate the poster/presentation to the concept of sustainability, and did not mention the use of environmentally friendly tools/objects.
2	Mentioning the concept of sustainability in general terms, but not clearly in examples or procedures.
3	Able to explain simple examples of the use of environmentally friendly tools/objects, although still limited.
4	Provide relevant and sufficiently detailed examples of the selection of sustainability-based tools/objects/procedures.
5	Demonstrating a deep understanding, with clear, innovative, and practical explanations related to sustainability.

Table 4. The following are the results of the students presentations

Score	Number of Students	Students Presentations (%)
2	4	11.1
3	17	47.2
4	7	19.4
5	8	22.2

As can be seen from the table, most students scored in the range of 3–4, indicating a fairly good understanding of sustainability. A few students stood out with a score of 5, meaning they were able to give practical examples (e.g., linking food waste to compost, maggots, or using food rescue apps). Only a few still scored low, usually because their presentation was unclear or their examples were irrelevant. The average score of all students was in the range of 3.5–4.0 (good category). Skill assessment based on indicators "Using tools, objects, and work procedures based on sustainability" was conducted on 36 students after the poster making and presentation activities. Scores were given on a scale of 1–5 (1 = very poor, 5 = very good). The following are the average scores of all students.

Table 5. Skills assessment results

N (Valid)	Mean	Median	Mode
36	3.35	3	3

As shown in Table 5, the average presentation score was 3.53, with both the median and mode at 3. These results indicate that the majority of students performed at a "sufficient–good" level. Although only a few students achieved the highest score (5), their ability to present clear and practical solutions demonstrates the potential of vocational students to apply sustainability concepts to real world problems.

Figure 4. Students presenting the posters they made

The findings indicate that vocational students can recognize food waste issues and propose practical solutions, although the sophistication of these solutions varies. Children can also act as proactive consumers who play a role in shaping solutions to food waste in schools (Yen et al., 2021). The frequent use of both problem and solution oriented terms in the posters reflects students' basic awareness of sustainability practices, such as composting and *maggot* based organic waste management. However, the relatively modest mean presentation score (3.53), indicates that many students' skills remain adequate rather than highly developed. These results indicate the need for targeted educational interventions. nteractive multimedia enhances motivation, improves learning outcomes, and supports higher order sustainability skills (Arisanti & Adnan, 2021).

The analysis of poster artefacts and classroom presentations shows that students possess a moderate level of sustainability skills. While the frequent use of solution- oriented terms such as *kompos* and *maggot* in the posters shows that students can recognise practical actions for reducing food waste, the presentation scores (Mean = 3.53; Median = 3; Mode = 3) suggest that their ability to communicate these ideas with depth and clarity is still developing. This gap between awareness and applied action reflects the challenges reported in previous sustainability literacy studies, where students often understand the issue conceptually but demonstrate limited capacity to apply practical and innovative solutions (Leal et al., 2024).

Food waste sustainability is recognized as a major economic, social, and environmental challenge, which has gained increasing academic attention (Attiq et al., 2021). In line with technological innovations, internet of things devices such as the "smart bin" have been introduced to make visible household food-wasting practices (Jones-Garcia et al., 2022). Embedding such forward-looking examples into learning activities will further strengthen students' ability to move from surface-level awareness toward higher-order, actionable sustainability competencies.

Conclusion

This study concludes that vocational students show a moderate level of sustainability literacy in the skills domain of food waste education. Poster artefacts reveal that students are able to recognize food waste issues and suggest simple practical solutions, such as composting and *maggot* use. Presentation assessments indicate that students' ability to communicate ideas remains limited in depth and innovation. These results confirm the existence of a gap between conceptual awareness and the practical application of sustainability solutions.

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