



Gaming Against Food Waste: Analyzing the Impact of Game-like Imagery in Reducing Food Waste at an All-Access University Dining Hall

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Executive Summary

Introduction

The urgency for actionable interventions is evident, with UBC's food waste contributing to 29,000 tonnes of CO₂ emission annually (UBC Board of Governors, 2021). Our study introduces a game-themed informative nudge to combat this problem at the university level, aiming to reduce food waste at UBC and set a precedent for future sustainable practices.

Research Question

How does game-like imagery impact food waste at an all-access university dining hall?

Methods

Our group developed three versions of a poster alternating in its mindful eating tips. We conducted a between-subjects experimental design spanning over two weeks, which included a four-day baseline period and an eight-day intervention period in which the posters were displayed around the food stations and high foot traffic areas; we observed and measured food waste disposal during this period. Observation data was quantified using a 5-point Likert scale, and average food waste per person was calculated using waste-weight and total entries during the experiment period.

Results

The Mann-Whitney U test calculated on the average waste disposal data revealed no significant reduction in the total food weight waste per person (kg) despite an observed decrease in avoidable food waste disposal, suggesting limited effectiveness of the gamified posters.

Recommendations

We would suggest doing further research with a longer intervention period with game-like imagery in the dining halls. Continuing observations after taking posters down post-intervention may also help track the robustness of the intervention. Furthermore, surveys can be conducted to study consumer behaviours, awareness of food waste reduction strategies employed by current research, and attitudes toward game-like posters (such as ours) about food waste. Future surveys could also focus on getting consumer feedback on menu items, allowing attendees to have more of a say in what they eat and reduce food waste through a more preferred menu list.

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Introduction

Environmental challenges are intensifying, and greenhouse gases produced from food waste are at the forefront of this multifaceted problem (Thapa et al., 2022). While *unavoidable* food waste contributes significantly to the rise of the greenhouse effect, a considerable portion can be controlled by managing *avoidable* food waste. The National Zero Waste Council (2022) found that 63% of Canadians' food waste was avoidable. Furthermore, the urgency for actionable interventions is evident, with UBC's food waste contributing to 29,000 tonnes of CO₂ emission annually (UBC Board of Governors, 2021). Our study introduces a game-themed informative nudge to combat this problem at the university level, aiming to reduce food waste at UBC and set a precedent for future sustainable practices.

Previous literature on sustainable practices has suggested using descriptive normative information in energy conservation efforts, highlighting the importance of considering social norms in designing interventions to reduce energy usage (Cialdini et al., 1991). Moreover, studies have implemented behavioural interventions underscoring the importance of precision and informed strategies to reduce food waste (Valkengoed & Steg., 2019). This emphasises the need to design adaptive experiments that increase the effectiveness of the intervention by utilising context-specific strategies.

Additionally, studies have implemented the social nudge theory: which finds that voluntary and non-intrusive interventions can induce behavioural change (Zhang et al., 2023). Recent studies have used different strategies: moral messaging (Chang et al., 2022), providing a sense of responsibility (Pinto et al., 2018), or using gamification with incentives and rewards (Huotari & Hamari, 2012; Zichermann & Cunningham, 2011). Such nuanced interventions are tailored to encourage specific behavioural changes without imposing, thus enhancing the efficacy of efforts to reduce food waste through heightened awareness and personal accountability."

Gamification is "the idea of applying game principles to non-gaming contexts (Deterding et al., 2011)." Studies have found that "gamification has the power to generate new habits through the reinforcement of desired practices (Duhigg, 2012)." A notable example of combining gamification and visual nudge was "No Scrap Left Behind," which employed Economic signage and trivia with prizes to reduce waste. Even though incentives were effective in changing behaviour, it was found that the gamification process itself had the power to create micro-level changes beyond monetary incentives (Koivisto & Hamari, 2014).

Despite notable advancements, a knowledge gap exists concerning the effect of gamification without external rewards on food waste reduction practices. We particularly leverage hedonistic aspects of game-like imagery in promoting sustainable practices, which have yet to be explored. Hence, there is a need to investigate how normative conduct theory can be harmonised with gamification principles to develop interventions that address food waste challenges. Our study aims to combine these elements of research by using gamified posters to act as a visual nudge at an all-access university dining hall. The novelty of our study lies in

a comprehensive approach that recognises the interdependence of environmental issues and provides a happy climate solution to reduce food waste.

Research Question

How does game-like imagery impact food waste at an all-access university dining hall?

Hypothesis

If food waste reduction tips are implemented into game-themed posters at a university dining hall, there will be a decrease in post-consumer food waste during the intervention period as compared to baseline levels.

Methods

Participants

We aimed to recruit a total of 467 participants based on the results obtained from an a priori power analysis. We targeted this sample size based on Cohen's medium effect size (0.13), an alpha level of 0.05, and an estimated power of 0.8. The total entries into the UBC open kitchen dining hall during the study period were 41,387. The number of students observed directly was 2,087. The participants consisted of first-year undergraduate students, dining hall staff members, and other dining hall attendees.

Conditions

The study employed a between-subjects experimental design. The independent variable in our study was the use of behavioural tips placed on gamified posters to reduce food waste. The control condition (N=840) had no posters up to allow us to get a baseline of the different measures, whereas the experimental condition (N=1247) had the presence of game-themed posters across the dining hall food stations. A total of 12 posters were placed in high-traffic areas near food stations after recommendations from staff members.

Measures

The dependent variable in our study was students' individual food waste disposal behaviours. This was operationalized using observed individual consumer food waste and tracked average individual food waste weight as measured by dining hall staff (kg/attendee). Individual food waste observations were recorded using a 5-point Likert scale [0 – No Waste: no avoidable food waste; 1- Minimal: slight excess, 1-2 extra pieces; 2 – Moderate: 3 – 5 pieces wasted, about half the plate; 3 – Significant: over half the plate has avoidable waste; 4- Severe: most of the food is thrown]. The average individual food waste was recorded by dividing total food waste weight by total number of attendees in the dining hall [recorded for all days during the experiment including weekends].

Procedure

We conducted an intervention by incorporating food waste reduction tips on game-themed posters placed in different locations in the UBC dining hall. Data collection took place starting from March 11th to March 22nd with a baseline period observed from March 11th to 14th [4 days], and the intervention period observed from March 15th to 22nd [7 days]. During the intervention period, food waste reduction tips were integrated into game-theme posters at locations within the UBC dining hall. We tracked two measures of individual food waste: observation and food waste per person.

For the observations, data collection was conducted by two team members utilizing a food waste scale. Observation data was collected during weekday dinners, particularly between the hours of 6 pm – 8 pm when the attendance was the highest. In the food waste per person analysis, dining hall staff members assisted in weighting the daily food waste in kilograms,

alongside providing information on the total number of individuals accessing the UBC open kitchen dining hall. Therefore, the average individual food waste was measured by dividing total daily food waste by the corresponding total number of dining hall visitors.

One notable challenge encountered during the intervention period was the consistent absence of two posters: one positioned near the food stations and the other near the entrances.

Results

Our research yielded two conflicting results. As for the observation data, the mean from the baseline period was 1.443 (N = 840), with a standard deviation of 1.293. The observation mean from the intervention period was 1.171 (N= 1,247), with a standard deviation of 1.293. For the food waste weight per person, the average from the baseline period was 0.0715 (N= 15,635), with a standard deviation of 0.0156. The average during the intervention was 0.1874 (N = 25,752), with a standard deviation of 0.2381.

In order to use a t-test, we needed the test's assumptions of equality of variance and normality distribution to be satisfied. However, one of the test's assumptions (equality of variance) was violated as indicated a Levene's test ($p > 0.05$) performed on the observation data. As for the food waste per person, a limited data point (12) was available. Hence, both evaluations were conducted using the Whitney—Mann Wilcoxon test for statistical analysis. The Whitney U test conducted on the data for food waste per person revealed no statistically significant change between the baseline and intervention periods ($W = 25$, $p > 0.05$, $r = 0.56$). However, analysis of observational data for the same period showed a statistically significant reduction in unavoidable food waste ($W=591,590$, $p < 0.05$, $r=0.13$) (Table 1). These results suggested an inconclusive result to our hypothesis.

Discussion

The study explored the role of game-themed imagery on the behavioural changes of all-access dining hall attendees. After evaluations, our results were inconclusive, suggesting that the posters had no impact on the attendees' behaviour. There was a significant reduction in observed food waste between the baseline and intervention periods; however, this reduction did not occur for the average food waste weight per person. This suggests that some external factors might have played a role in one of our metrics. We noted a spike in observations valued at 0 avoidable food waste in the experimental condition. This may suggest a difference between *unavoidable* and *avoidable* waste, which the weight data did not pick up, but the observations did. Nevertheless, it is more likely that this discrepancy resulted from other variables such as dining hall attendee preferences for different weekly menu items, the weight of unavoidable food waste (such as bones, paper napkins), data collection during weekends for average food waste per person but not for observations, or observational bias on the part of the researchers.

Our study attempted to demonstrate that game-themed posters can act as a visual cue to frame food waste reduction as a challenge and nudge dining hall attendees to change their behaviours to “beat food waste.” Dining hall attendees may be prompted to try various behavioural changes that help reduce food waste in the long run by asking for smaller portions, finishing all the food on their plates, or returning later for seconds, etc. Though our results were inconclusive, they did recognize a reduction in avoidable food waste as seen in changes in the observation data. Building on past studies that utilized interactive game-like elements to prompt food waste (Helmefalk & Rosenlund, 2020; Soma et al., 2021), our study explored the ability of relatively less interactive posters to prompt similar reductions.

Some key limitations of our study were as follows: (1) observational bias on the part of the researchers may have influenced the ratings of food waste due to an unblinded study. Though we had two researchers placed at any time for the observations, researcher bias could not be fully eliminated. (2) We also observed a low sample size of food waste weight data relative to the total dining hall attendee size. This may reduce the reliability and power of our results in truly defining the behaviours of all dining hall attendees. (3) Two out of twelve posters were lost/taken down when researchers went to observe on Monday, March 18. These posters were replaced on Tuesday, March 19. Their takedown may reflect that (3a) either attendees or staff members deliberately removed these posters (reflecting opposition to the topic of food waste reduction) or (3b) unknowingly removed them (reflecting a lack of attention to the topic). Lastly, researchers conducted observations from a room above the dining hall that led to (4) a limitation to our observation space: a wall surrounding the food waste disposal bins that obstructed the view of one of the disposal bins. This could have created inaccurate assessments of some observations. Napkins placed in bowls and plates on top of food waste also obstructed the view and impacted food waste assessments.

Implications

Exploring the use of game-like imagery to promote environmental sustainability efforts represents a growing area of research (Soma et al., 2021; Helmefalk & Roselund., 2020). We investigated how linking food waste reduction behaviours with enjoyment from video games or gamified challenges (such as competition between different groups) can further enhance addressing post-consumer food waste issues. Our research found that visual nudges can have

an impact on changing behaviours in the short-term. Placing posters near consumption areas, rather than waste disposal areas, led to a reduction in observed post-consumer food waste showing the importance of preventative behavioural interventions. While past research has used gamification principles either alone or in conjunction with poster messaging, our study is novel in its application within a university dining hall setting and using gamification principles without the use of external rewards, providing a foundational framework for future research. However, our research's short intervention period concluded that any impact of gamified imagery may be minimal due to inconclusive results.

Future studies can explore performing a double-blind study and keeping track of food menu items. With these modifications, the issues of observation bias and possible food menu effects on the data can be eliminated, and the results can be more reliable. Furthermore, exploring different forms of messaging with game-like imagery, such as traditional food waste visualizations, or moral messaging (Chang, 2022) could be beneficial. This approach would help assess how informational tips influence behavioural changes compared to other messaging styles. Another avenue for exploration is investing in interactive digital interventions that can track attendee engagement with the intervention to note direct impacts of the intervention on behaviour change.

Although our study focused on Pac-Man imagery due to its prominence in pop culture, future studies could investigate the use of contemporary imagery reflecting the current zeitgeist to evaluate its impact on behavioural change. Additionally, research can explore the durability of game-like imagery and posters designed to reduce food waste. Experimental designs can observe food waste reductions in dining halls over extended periods, comparing average waste levels before and after the intervention. Furthermore, expanding the intervention to include game-like imagery on napkin holders and disposal bins can also be studied. This approach would allow for the messaging to create an impact for future visits after the food has already been picked, possibly creating a more memorable effect due to the presence of the attendee's waste in conjunction with the messaging.

Recommendations

We would suggest doing further research that follows the above suggestions including holding a longer intervention period with game-like imagery in the dining halls to note the sustainability of the poster's impact. Due to the short time of our study, it is possible our results were more readily impacted by non-poster-related issues (such as menu changes or changed consumption patterns during "midterm" season, etc.). Continuing observations after taking posters down post-intervention may also help track the robustness of the intervention. Furthermore, surveys can be conducted to study consumer behaviours, awareness of food waste reduction strategies employed by current research, and attitudes toward game-like posters (such as ours) about food waste. Studies could conduct surveys that ask consumers for their responses to the posters, or ask staff members if they noticed an impact in requests for smaller portions, etc. This will further showcase the efficacy of poster-based interventions and allow the clients to have a more accurate understanding of which interventions to engage in. Future surveys could also focus on getting consumer feedback on menu items, allowing attendees to have more of a say in what they eat and reduce food waste through a more preferred menu list.

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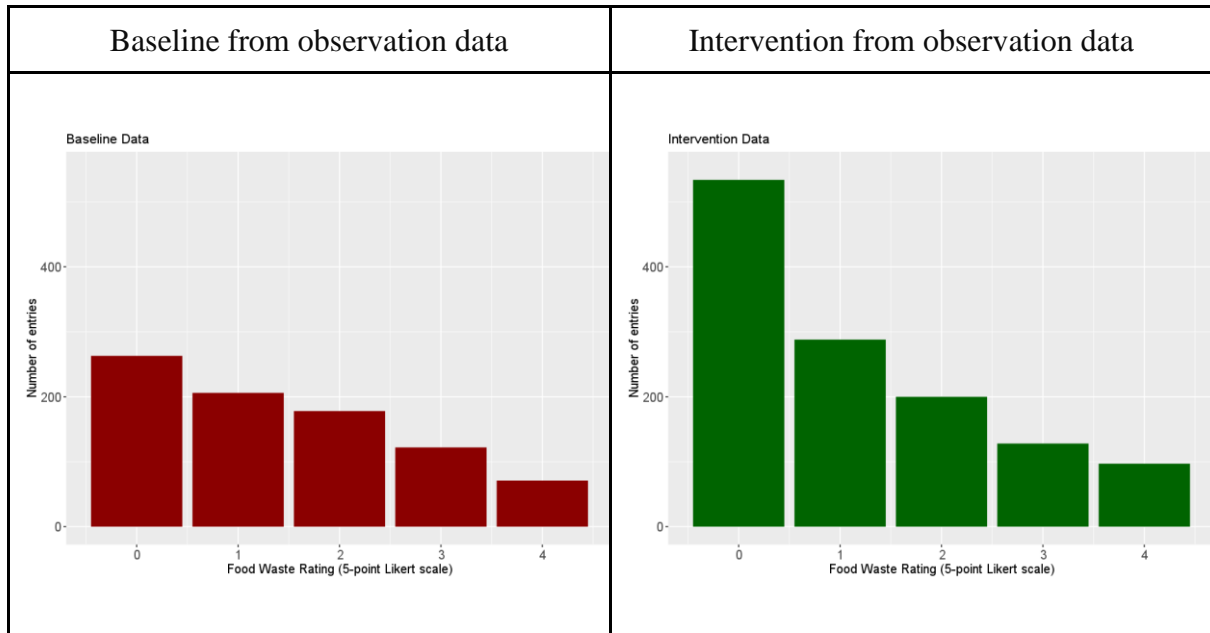
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Appendices

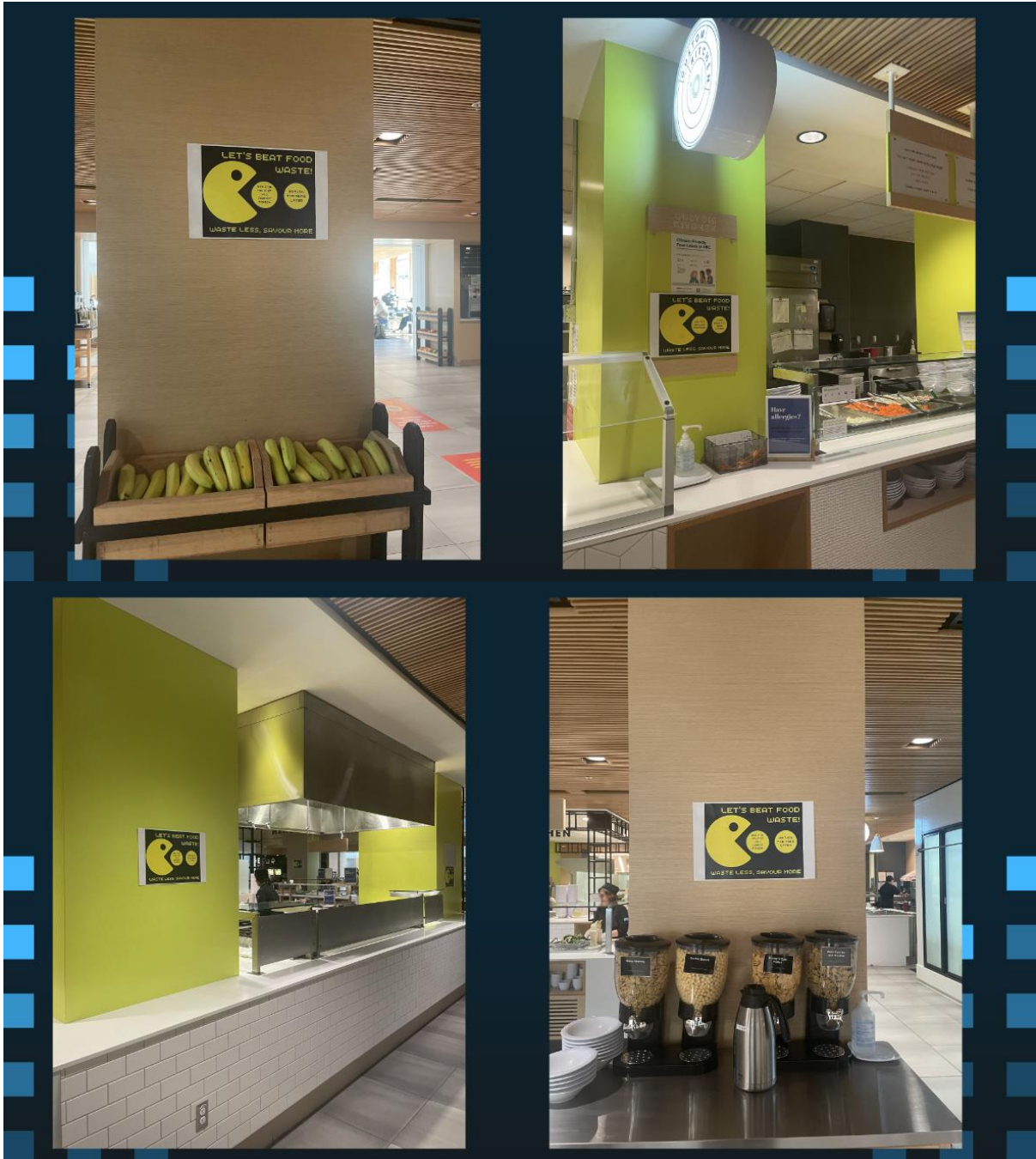
Appendix A: Table 1 Baseline and Intervention Data



Appendix B: Game-like Themed Food Waste Reduction Posters



Appendix C: Poster placement at the open kitchen dining hall



Appendix D: Food Waste Scale

