

The Winning Plate: Visual Signage & Conditional Incentives as a Nudge for Plate Waste Reduction

Group name: Save on Food

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Executive Summary

University all-access dining halls generate considerable food waste due to the lack of immediate consequences for uneaten food. This study investigated whether visual signage paired with a conditional lottery incentive could reduce plate waste in an all-access university dining hall. We conducted a between-subjects field experiment at UBC's Open Kitchen. During the baseline condition, no intervention was present. In the experimental condition, 10 posters were displayed in Open Kitchen's dining area. The poster depicts a clean plate and a QR code for the chance to win a \$50 gift card. Plate waste was measured using two methods: (1) observational ratings of participants' plates and (2) daily plate waste (kg) per customer. Results from observational data showed a significant reduction in plate waste during the experimental condition ($Mdn = 0.5$) compared to baseline ($Mdn = 1$), $U = 590706$, $p < .001$, $r = .138$. Despite a numerical reduction, plate waste (kg) data were not significant, $t(12) = 0.398$, $p = 0.698$, $d = .222$, likely due to a small sample size. These findings suggest that a low-cost signage and incentive strategy can reduce plate waste. Future research should aim to understand the underlying mechanism and long-term feasibility of incentive-based interventions in reducing food waste.

Introduction

In line with their Zero Waste Action Plan 2030 (ZWAP2030), UBC dining halls have undergone a series of changes, including the switch to all-access residence dining, elimination of single-use plastics and takeout packaging, as well as offering smaller portion sizes (UBC Campus & Community Planning, 2023). However, all-access dining introduces a new problem: since students pay an upfront flat fee for their meal, there is no consequence for food waste, making it easier for students to take large amounts of food without feeling too much remorse for then throwing it away (Nikolaus et al., 2018). Coupled with the fact that young adults aged 18 to 24 are a large contributor of avoidable food waste, university dining halls are an ideal environment for implementing food waste reduction strategies and may make a considerable impact towards reducing overall food waste (Clement et al., 2023; Nikolaus et al., 2018).

Evidence for the effectiveness of behavioural interventions is supported by Katare et al. (2019), who focused on the effect of economic incentives in an all-access university dining hall and explored whether a fixed monetary incentive for those who finish their food would lead to a reduction in food waste. Their results showed that those offered the financial incentive were more likely to finish all of their food, thereby reducing the amount of dining hall food waste (Katare et al., 2019). This finding aligned with a past meta-analysis reporting the effectiveness of financial incentives in promoting proenvironmental behaviours (Maki et al., 2016). Additionally, visual signage has proven to be another effective intervention. Ellison et al. (2019) reported an insignificant but modest decrease in food waste after a visual signage intervention. They found that posters with food waste facts and messaging produced a small reduction in daily average food waste per student (Ellison et al., 2019). Similar findings have been summarized by Tian et al. (2022), who conducted a meta-analysis to consolidate existing research on food behaviour interventions and the differences in their effectiveness. They identified seven types of interventions: prompt, education, incentive, feedback, consequence, tips, and environmental alterations (Tian et al., 2022). Interestingly, they found that nearly a third of the existing literature utilizes prompt interventions where information about food waste is presented to participants, often through posters, with the aim of targeting food waste behaviour (Tian et al., 2022). Yet, only 1.7% of studies were found to examine incentivization methods, despite ranking second most effective (Tian et al., 2022).

To address this knowledge gap, we combined visual signage and conditional incentives and offered an interactive component with the aim of reducing plate waste in a dining hall. Based on a thorough search of the existing literature, we believe that this is the first study of its kind. Our research question asks how visual signage with a conditional lottery incentive influences the amount of plate waste in an all-access university dining hall. We hypothesize that the presence of the visual signage with a conditional lottery incentive—a chance to win a \$50 gift card for uploading photos of clean plates—will reduce the amount of plate waste in an all-access university dining hall compared to the baseline condition.

Methods

Participants

An a priori power analysis was conducted for a two-tailed independent samples *t*-test using G*Power. A minimum total sample size of 788 participants in total, 394 participants for

each condition, was required, based on an effect size of $F = 0.2$, $\alpha = .05$, power = .80. We recruited a total of 2132 participants, with 752 in the baseline condition and 1380 in the experimental condition. The sample includes all customers at Orchard Commons' Open Kitchen, composed primarily of UBC students, faculty, and staff. No demographic information was collected. First-year students likely made up most of the sample since the meal plan is mandatory for them.

Conditions

Our study was a between-subjects field experiment with two conditions. The baseline condition ($N = 752$) ran from February 26th to March 3rd with no intervention. There was no signage about food waste in Open Kitchen during the baseline condition. The experimental condition ($N = 1380$) ran from March 4th to March 14th, during which our independent variable, an intervention of 10 signage posters with conditional incentive messaging, was displayed in the dining area. The poster design is shown in Figure A1, and its locations of display are depicted in Figure B1 (see Appendices A and B). Customers eating at Open Kitchen could scan the QR code on the poster to be directed to a Qualtrics survey. The survey, as shown in Figure C1, presented participants with a consent form before they were able to upload pictures of their clean plates and enter their email addresses to enter the lottery for a \$50 gift card (see Appendix C).

Measures

Our dependent variable was the average amount of plate waste per customer operationalised in two ways: plate waste observations and plate waste (kg) per customer measured by researchers and UBC Food Services, respectively. Firstly, researchers collected plate waste observation data at Open Kitchen from 5 p.m. to 9 p.m. on weekdays throughout the course of the study. Researchers used the quarter-waste method, shown in Table D1, as the observation scale to visually estimate plate waste per meal by assigning each customer's plate a value ranging from 0-4 where 0, 1, 2, 3 and 4 represents 0%, 25%, 50%, 75% and 100% of food wasted respectively (See Appendix D). Past studies have compared this method against weighted data and concluded it to be a valid and reliable tool for measuring plate or tray waste in school dining settings (Getts et al., 2017; Hanks et al., 2014). Two observers were present to observe the same participant at a time. The individual plate waste score was calculated by taking the average of two ratings from the observer pairs for the same participant. Inter-rater reliability was calculated using the Intraclass Correlation Coefficient (ICC). Secondly, UBC Food Services provided the total weight of plate waste in kilograms and the number of card swipes to represent the number of customers per day. This weight data included both avoidable and unavoidable food waste, such as paper napkins, bones, and other scrap waste from the kitchen. From this, the average plate waste per customer was calculated by dividing the total plate waste weight in kilograms by the number of card swipes.

Procedure

The posters were displayed in Open Kitchen's dining area on the night of March 3rd after closing, marking the start of our experiment. Three sets of announcements were made in a WRDS150 class, mandatory for first-years, to advertise our study to the target population. Daily observation periods were split into two shifts—5 p.m. to 7 p.m. and 7 p.m. to 9 p.m.—with two

researchers present during each shift. After discreetly deciding which customer's plate to rate, each researcher input their rating into a spreadsheet in invisible white font to ensure an independent rating. Daily plate waste (kg) data was provided by UBC food services.

Results

Plate Waste Observation

From the observation measure, the average plate waste score per customer in the experimental condition ($M = .80$, $SD = 1.00$, $N = 1380$) was lower than that in the baseline condition ($M = 1.03$, $SD = 1.06$, $N = 752$). The ICC(1,1) result was 0.88, 95% CI [.87, .89], indicating a high agreement between observer pairs and good reliability in the ratings. To investigate whether the signage posters affected individual plate waste, a two-tailed independent samples t -test was used. Before conducting it, the assumptions were checked. While Levene's test showed that the assumption of equal variances was met, $F(1, 2130) = .27$, $p = .60$, the Shapiro-Wilk test suggested a deviation from normality in the baseline condition ($W = .86$, $p < .001$) and the intervention condition ($W = .79$, $p < .001$). Therefore, a Mann-Whitney U test was used as the nonparametric alternative. This found a significant difference between the baseline condition ($Mdn = 1$) and the experimental condition ($Mdn = .5$), $U = 590706$, $p < .001$, $r = .138$. The difference in the medians of plate waste scores was illustrated in a box plot in Figure E1 (see Appendix E). Though with a small effect size, the result suggested that the intervention reduced plate waste behaviours, supporting the hypothesis.

Plate Waste (kg) per Customer

The plate waste (kg) per customer measure in addition to the observation showed that the mean daily plate waste weight per customer during the intervention period ($M = .082$, $SD = .022$, $N = 9$) was lower than that during the baseline ($M = .086$, $SD = .017$, $N = 5$). The assumptions were checked for an independent samples t -test, with the Shapiro-Wilk test indicated that the data were normally distributed for both baseline ($W = .82$, $p = .11$) and intervention ($W = .93$, $p = .43$), and Levene's test showed that the homogeneity of variances was met, $F(1, 12) = .22$, $p = .65$. A two-tailed independent samples t -test was then carried out to compare the plate waste data before and after the intervention. Although the intervention period showed a slightly lower mean compared to the baseline period, the difference was not statistically significant, $t(12) = .398$, $p = .698$, $d = .222$, which failed to support the hypothesis. A bar graph depicting group means with standard error is shown in Figure E2 (see Appendix E). Importantly, these results should be interpreted with caution due to the small sample size of measurement days ($N = 14$), which limits the statistical power of the analysis.

The overall findings partially supported the hypothesis, as the observational data showed a significant reduction in individual plate waste after implementing the signage posters, but the plate waste data did not provide supplementary evidence at the aggregate level.

Discussion

The purpose of our study was to explore the combined effects of visual signage and conditional incentivization on reducing plate waste at an all-access university dining hall. This

intervention was successful considering a reduction in both plate waste observation data and plate waste (kg) data, with a significant result in the former.

Implications

The results of this study provide evidence that a low-cost, visual signage and conditional incentive-based intervention can effectively reduce plate waste in an all-access university dining hall. As the poster involved multiple aspects in its design—the visual representation of a clean plate, the prompt “Can you lick yours cleaner?”, and the conditional lottery incentive—it is difficult to calculate the contribution of each aspect to the change in plate waste. However, we speculate that the effectiveness of the intervention was an interaction between the three components: the visual representation of the “attractive” clean plate provided a point of comparison for the participant, the chance of winning a \$50 gift card offered an additional nudge to produce that behaviour, and the interactive QR code component acted as a call to action to perform that behaviour in the moment.

One important thing to consider is the information provided by the Qualtrics survey – a total of 107 responses, 92 valid entries for the lottery and 33 unique participants. While not an explicit measure of our experiment, the survey results offer valuable insight into participant engagement with our study. In particular, 33 unique participants make up less than 2% of the 1380 individuals observed in the experimental condition, yet there was a reduction in plate waste. We propose the following three reasons for this discrepancy.

One possible explanation is that the conditional incentive was not the primary aspect of the poster influencing the participants. Perhaps the visual representation of the clean plate and prompting line was enough to influence plate waste behaviour, and the conditional incentive had a minor effect in comparison. According to Dijksterhuis and Bargh (2001), the tendency to imitate behaviour is an automatic one where no motivation or conscious thought is required. In relation to our study, the image of the clean plate could have caused people who merely viewed the poster to unconsciously engage in imitation, thereby finishing their food. Despite not directly participating in our study by completing the survey, these tendencies can explain why there was still a decrease in plate waste during the experimental period.

A second explanation is that viewing the poster sparked conversations about food waste, which influenced the food waste behaviour of those who had not seen the poster itself. Referring back to Dijksterhuis and Bargh (2001), they argue that our tendency to imitate the behaviour of others stems from a need for belonging. Discussions around food waste, therefore, could have contributed to a reduction in plate waste due to individuals desiring to be socially accepted.

A third explanation may be that a group of individuals collaborated on one entry. Some of the photo submissions were clearly taken by another person, providing some evidence for this idea, and this level of engagement was enough for them to feel as though they had participated. However, as the overall survey participation rate is low, this is a weaker explanation.

All in all, these findings build upon past studies and advance our understanding of food waste reduction interventions in a number of ways. Consistent with Katare et al. (2019) and Ellison et al.’s (2019) studies, our significant results potentially advocate for the effectiveness of both economic incentives and visual signage interventions in all-access dining halls, respectively. However, as one of the first studies to explore the combined effect of visual signage and conditional incentives, it addresses a knowledge gap. Furthermore, although the study ran for a little less than three weeks, significant results were recorded, demonstrating how this combined intervention can significantly reduce plate waste in a short-term period despite low engagement levels. Moreover, while theoretical, the explanations offered in this paper raise a question about the role of social influence in reducing plate waste, indicating an area for further study. Overall,

the observed plate waste reduction aligns with UBC's mission for sustainability as outlined in their ZWAP2030 (UBC Campus & Community Planning, 2023). The success of this intervention provides a useful, easy-to-implement intervention that may be extended to other dining halls and universities wishing to achieve similar goals, and offer broader implications on plate waste reduction in similar contexts, such as restaurants or hotel buffets.

Limitations

Insignificant plate waste (kg) data may be due to limited data points and/or the inclusion of avoidable food waste in the plate waste weight. The plate waste data was recorded daily, providing us with only fourteen data points. This small sample size could have limited the statistical power of the analysis, resulting in a possible Type II error. Furthermore, the observational data focused solely on avoidable food waste, whereas the total weight of plate waste provided by UBC Food Services included both avoidable and unavoidable food waste, such as paper napkins, bones, and other kitchen waste. As such, the average plate waste weight per customer calculated may not provide a true measure of plate waste in kilograms.

Some unexpected challenges also arose during observational data collection. Most notably, the dishes that were easiest to see and rate were those that were either flat (i.e., plates) or empty (i.e., clean or without tissues on top obscuring food), meaning that researchers were more likely to input ratings of 0. Customers also tended to take multiple dishes and stack their plates for return, which made it difficult to rate accurately. To address this, taking pictures or recording with a camera may provide researchers with more time to accurately assess plates.

Another notable limitation is that this study was not double-blind, and thus may be more susceptible to observer bias. A double-blind study could prevent researchers' ratings from being harsher during the baseline condition and/or more lenient during the experimental condition.

Finally, one unavoidable event was Ramadan, which began on the evening of February 28 and ended on March 29, overlapping with our data collection. Since we did not collect demographic data, the proportion of the participant population taking part in Ramadan is unknown, but we believe that this was a possible confounding factor that could have influenced plate waste (kg) data.

Future Directions

Potential replication studies should use a larger sample size to more reliably assess the impact of the intervention on food waste. To evaluate the mechanisms speculated above, studies that explore the individual contributions of visual signage and conditional incentives in a combined intervention may be useful. Additionally, where the feasibility of a bi-weekly \$50 gift card incentive is concerned, future studies may aim to explore how long-lasting behaviour change can be made by studying the use and effectiveness of alternatives to lottery incentives and economic rewards. Lastly, beyond the scope of our study, future studies could examine the role of social influence as a mediating factor and different intervention combinations to compare effectiveness.

Recommendations for UBC Client

In line with UBC's target of reducing greenhouse gas emissions of food systems by 50% by 2030, we recommend implementing this intervention across all first-year dining halls (Open Kitchen, Feast and Gather) to maximise efficacy (UBC Campus & Community Planning, 2023). However, considering only 33 unique customers participated in the photo submission aspect of the poster, there are a number of actions SEEDS can take to increase engagement. Raising awareness amongst dining hall customers should be a priority. This can be done by displaying the posters across campus, making social media posts on official UBC accounts (e.g. UBC Sustainability, Nutrislice, or first-year residence Instagram accounts) or sending email announcements to first-year students. Using larger posters may also help to enhance visibility to customers of the dining halls. Putting a creative spin on the photo submission contest, such as encouraging participants to pose with their clean plates, could add a fun element which could make customers more inclined to participate. Displaying past photo submissions near compost bins may also act as a motivator. Lastly, according to Open Kitchen's sous chef Darren Clay, the food waste peaks during the first 4 to 6 weeks of the school year. Taking this into account, we recommend implementing the intervention during specific periods for three reasons: to target periods with the highest amount of food waste, mitigate the risk of customers becoming desensitised to the posters, and shape customers' behaviour.

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Appendix A

Poster Intervention with Conditional Incentive Messaging

Figure A1

Poster Design Displayed in Open Kitchen

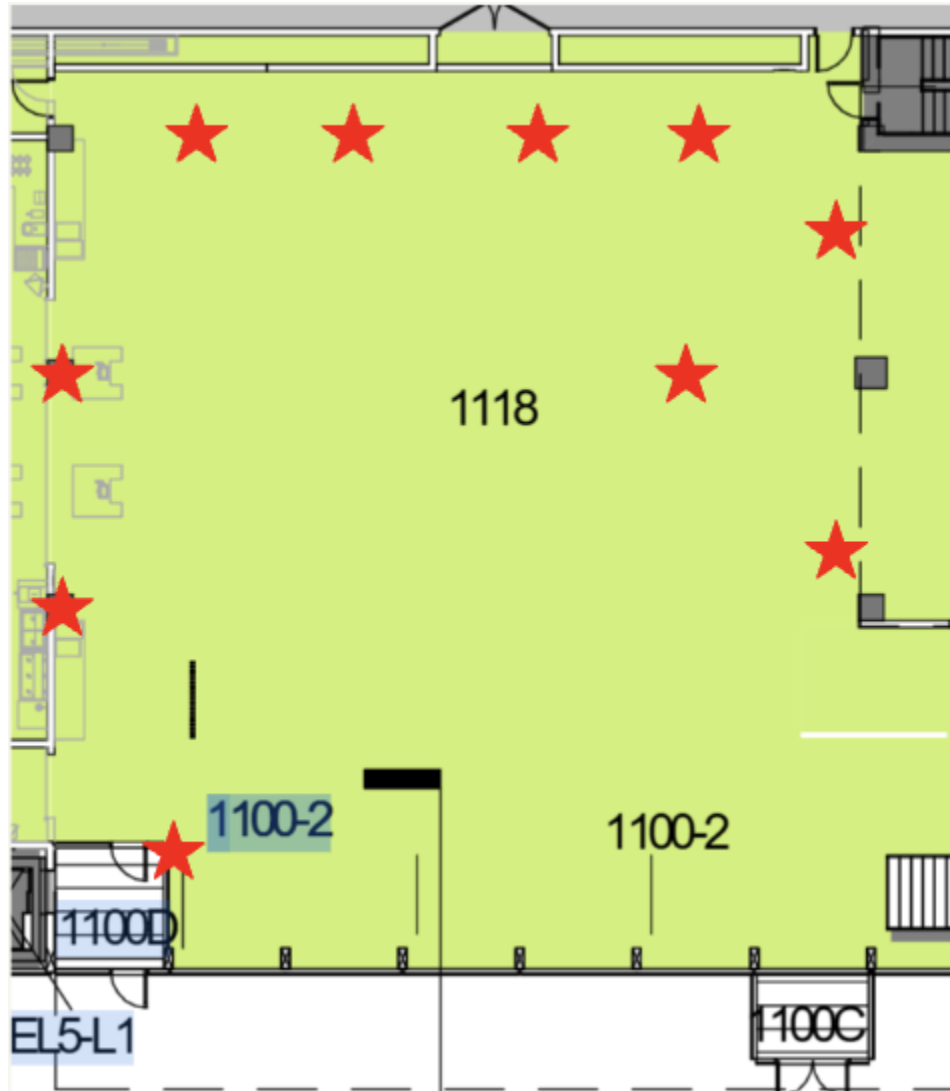


Appendix B

Map of Open Kitchen Dining Hall

Figure B1

Dining Hall Floor Plan with Poster Locations



Note. The red stars depict the 10 poster locations within the dining hall.

Appendix C

Qualtrics Survey for the Lottery

Figure C1

Qualtrics Survey with Conditional Incentive Messaging

Take a picture of your clean plate for a chance to win a \$50 gift card!

The lottery prize draw is part of a student group research project for PSYC 421: Environmental Psychology in collaboration with UBC's SEEDS Sustainability Program.

To enter, please read the consent form below.



UNIVERSITY OF BRITISH COLUMBIA

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Consent Form

Class Research Projects in PSYC 421 - Environmental Psychology

Principal Investigator: Dr. Jiaying Zhao
Course Instructor
Department of Psychology
Institute for Resources, Environment and Sustainability
Email: jiayingz@psych.ubc.ca

Introduction and Purpose

Students in the PSYC 421 – Environment Psychology class are required to complete a research project on the UBC campus as part of their course credit. In this class, students are required to write up a research proposal, conduct a research project, collect and analyze data, present their findings in class, and submit a final report. Their final reports will be published on the SEEDS online library (<https://sustain.ubc.ca/teaching-applied-learning/seeds-sustainability-program>). Their projects include online or in-person surveys and experiments on a variety of sustainability topics, such as waste sorting on campus, student health and wellbeing, food consumption and diet, transportation, biodiversity perception, and exercise habits. The goal of the project is to train students to learn research techniques, how to work in teams and work with UBC clients selected by the UBC SEEDS (Social Ecological Economic Development Studies) program.

Study Procedures

If you agree to participate, the study will take 5-10 minutes of your time. You will answer a few questions in the study. The data will be strictly anonymous. Your participation is entirely voluntary, and you can withdraw at any point without any penalty. Your data in the study will be recorded (e.g., any answer you give) for data analysis purposes. If you are not sure about any instructions, please do not hesitate to ask. Your data will only be used for student projects in the class. There are no risks associated with participating in this experiment.

Confidentiality

Your identity will be kept strictly confidential. All documents will be identified only by code numbers. No personally identifying information will be collected. Data that will be kept on a computer hard disk will also be identified only by code numbers and will be encrypted and password protected so that only the principal investigator, also the course instructor, Dr. Jiaying Zhao, and the teaching assistants will have access to it. Following the completion of the study, the data will be transferred to an encrypted and password protected hard drive and stored in a locked filing cabinet. Please note that the results of this study will be used to write a report which is published on the SEEDS library.

Remuneration

There is no remuneration for your participation.

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Contact for information about the study

This study is being conducted by Dr. Jiaying Zhao, the principal investigator. Please contact her if you have any questions about this study. Dr. Zhao may be reached at (604) 827-2203 or jiayingz@psych.ubc.ca.

Contact for concerns about the rights of research subjects

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

Consent: Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time. You also may postpone your decision to participate for 24 hours. You have the right to choose to not answer some or any of the questions. By clicking the "continue" button, you are indicating your consent to participate; hence, your signature is not required. The researchers encourage you to keep this information sheet for your records. Please feel free to ask the investigators any additional questions that you have about the study.

Ethics ID: H17-02929

By clicking "Yes, I consent to participate" , you consent to participating in this survey and having your survey responses included in the prize draw and the research analyses.

☐ Yes, I consent to participate.

☐ No, I do not want to participate.

Next

Upload a photo of your clean plate here for a chance to win the prize!

Note the following rules and criteria to enter:

1. A "clean plate" doesn't necessarily mean an empty plate. Unavoidable plate waste (e.g. bones, fruit peels) is acceptable.
2. Only customers at Open Kitchen are allowed to participate in this lottery prize draw.
3. Every day, you may submit up to 3 entries (i.e. 3 meals) to increase your likelihood of winning the prize.
4. You have a maximum of 33 chances of winning! (i.e. by being part of the clean-plate movement during every meal until 3/14)
5. Multiple entries around the same time will only be counted as one entry.
6. There is 1 prize (a gift card worth \$50) to be won and the randomly selected winner will be notified via email on 3/17 (Monday).

Drop files or click here to upload

I am uploading my photo from Open Kitchen...

☐ Yes

☐ No

My email address is...

To be notified if you win the \$50 gift card!

Finish the survey

Appendix D

Quarter-Waste Method for Observing Food Waste

Table D1

Observation Scale for Quarter-Waste Method

0 means food is all finished	1 means 25% wasted	2 means 50% wasted	3 means 75% wasted	4 means food is all wasted
				

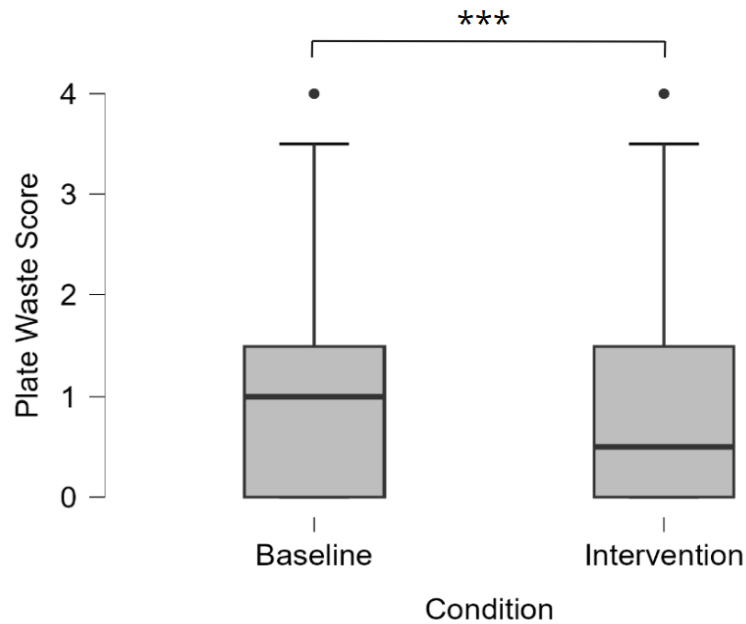
Note. Table C1 was created for this study and used as a point for comparison for ratings.

Appendix E

Visual Representation of Plate Waste Data

Figure E1

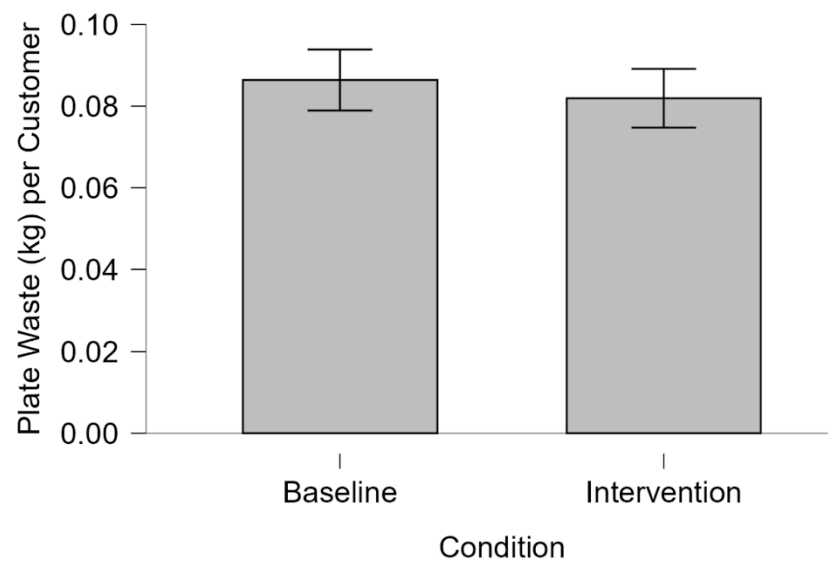
Difference in Medians of Plate Waste Observation Scores Before and After Intervention



Note. *** indicates $p < .001$ based on the Mann-Whitney U test.

Figure E2

Mean Plate Waste (kg) per Customer Before and After Intervention



Contribution of Each Group Member

Aki

- Review of current literature on food waste
- **Proposal:** methods
- **Data collection**
- **Presentation:** slides, script
- **Report:** methods, discussion

Bella

- Review of current literature on food waste
- **Proposal:** background literature, appendices
- **Data collection**
- **Presentation:** slides and script for implications and recommendations
- **Report:** methods, discussion, recommendations

Biying

- Qualtrics design and analysis
- **Proposal:** methods
- **Data collection**
- **Presentation:** slides, script, presented
- **Report:** methods

Edward

- **Proposal:** conditions
- **Data collection**
- **Presentation:** slides, script, presentation
- **Report:** discussion, recommendations

Lynn

- Review of current literature on food waste
- **Proposal:** background literature, references
- **Data collection**
- **Presentation:** slides, script, presented
- **Report:** introduction, discussion, appendix, references

Vendy

- Poster design
- First-year class announcements
- **Data collection**
- **Presentation:** slides, presented
- **Report:** executive summary

Yifan

- Review of current literature on food waste
- **Proposal:** methods
- **Data collection and analysis**
- **Presentation:** slides, script
- **Report:** results, appendices

For the project approval and check-in meetings, as well as any meetings outside of class time, everyone who was available attended, and those who did not communicated ahead of time and were updated later via the group chat.

Everyone was present for data collection shifts. Although we aimed to collect data every weekday during the course of our study, there were 6 out of 26 shifts where no two people were

available. Thus, we opted to not collect data on those shifts considering the need to have two researchers present to ensure inter-rater reliability and calculate the ICC.