# Gettin' Trashy: Comparing engagement strategies on waste sorting behaviour

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**Gettin' Trashy: Comparing engagement strategies on waste sorting behaviour**

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**Executive Summary**: Exposing individuals to engagement strategies have gained popularity as a creative solution to increase recycling rates (Peter, Graham, & Stoker, 2009). We aimed to assess how waste sorting behaviour is influenced when participants play an online sorting game in comparison to participants who play the online game and are exposed to visual cues. To test our hypothesis, different degrees of exposure to two types of student engagement strategies were implemented within Marine Drive towers 1 and 5 to compare the effects on waste sorting behaviour. We predicted participants exposed to both the 3D displays and interactive online waste sorting game will have higher participation and accuracy in waste sorting behaviours than those who were not exposed to both interventions. Our results showed that students exposed to the online sorting game sorted organic products at a higher rate than those in our control group. Our intervention informed students on proper waste sorting behaviours, which through the ripple effect, will extend to the surrounding communities and contribute to the lowering of lifetime greenhouse gas emissions on campus and beyond (Barsade, 2002).

**Research Question:** How is sorting behaviour influenced when participants play an interactive online sorting game in comparison to participants who play the game and are exposed to a visual cue in the form of 3D displays?

**Hypothesis:** Participants exposed to both the 3D displays and interactive online sorting game will have higher participation and accuracy in waste sorting behaviours than those who just play the interactive online waste sorting game.

**Participants:** The overall sample was the number of residents in Marine Drive towers one, four, and five combined. There are a total of 1,115 residents in all three towers. The independent sample consisted of the number of residents in each tower. Tower one has 342 residents, tower four has 406 residents, and tower five has 367 residents. The sub-sample of those that participated in the online waste sorting game intervention was 156 participants in tower one, and 169 participants in tower five. All the 342 residents in tower one were exposed to the 3D displays, making them the sub-sample of that intervention. All participants in our experiment were over the age of 19 due to the minimum age requirement in Marine Drive towers.The population that the study wanted to generalize the results to is the UBC community of students.

**Conditions:** There were two treatment conditions, towers one and five, and one control condition, tower four. The independent variables were different degrees of exposure to two types of student engagement strategies; 3D displays and the interactive online waste sorting game. Participants in tower one were exposed to both the 3D displays and the interactive online waste sorting game. Participants in tower five were only exposed to the online waste sorting game. Participants in tower four were exposed to neither of the interventions. The dependent variables were participation in waste sorting behaviour and waste sorting accuracy. The design of the study was quasi-experimental, because the experimenters were unable to randomly assign participants to the treatment or control conditions.

**Measures:** Sorting participation was measured by weighing the waste contents within each waste bin. Sorting accuracy was measured as contaminants per kilogram of waste. Sorting participation and sorting accuracy were measured and compared both before and after our interventions and between the towers. We conducted our experiment where a pre-established waste sorting facility existed. Bins in each of the three towers were labeled as paper, containers, and compost prior to the experiment. The weights of the bins were measured four times per week, and data was recorded for two weeks prior to the intervention and for 2 weeks after the intervention. All waste deposited into these bins were from the residents of the building. Each bin was measured separately. The average weight of an empty bin was 12 kilograms and this weight was subtracted from the attained weight to find the actual weight of the waste contents in each bin. Contamination was measured by visual inspection. The contamination rate was calculated by dividing the weight of a bin's contents by the number of contaminants within the bin to find the rate of kilograms per contaminant. This rate of contamination was calculated for each refuse type in each building on each measuring day. (See Appendix E - Figure 2).

**Procedure:** There were tables set up in the lobbies of buildings one and five for five days a week, from February 2 to March 17, 2016. At a single session, there would be two to three volunteers engaging residents coming in and out of the building with the online sorting game for a period of two hours. The tables contained posters, chocolates, an Apple iPad 2, and a Lenovo laptop computer (See Appendix D - Figure 2,). Participants were offered chocolate as an incentive for their participation. The online sorting game required participants to select which bin a waste item should be sorted in. The four sorting options in the game were recyclable containers, paper, compost, and garbage. If the student chose the correct bin to sort the waste item in, they were given positive feedback on the screen. If the student chose the incorrect bin to sort the waste item in, they were informed of the mistake and of the correct bin the item should have been sorted in (See Appendix B). There were 28 pictures of waste items in total that the participants had to go through to reach the end of the game. At the end of the game, participants were given their total accuracy and were then asked to fill out a short questionnaire requesting the following demographic information: gender, age, ethnicity, status at UBC, years spent at UBC, and whether they lived in tower one or five (See Appendix C - Figure 1). The students were then offered chocolates upon completion of the questionnaire. Tower one had 3D displays installed above the communal waste bins where students dropped off waste from their individual rooms, while towers four and five did not have 3D displays. The 3D displays contained examples of appropriate items to place in their respective bins (See Appendix C - Figure 2). A bin would be weighed by rolling it onto an industrial scale and then recording its weight and building number. Organic bins from each tower were measured three times a week: Tuesdays at 3:00pm, Thursdays at 3:00pm, and Sundays at 11:00am. Paper and recyclable container bins from each tower were measured two times a week: Wednesdays at 10:00am and Sundays at 11:00am. Contamination of waste contents were measured by visual inspection of the top of the bins contents. Items found to be improperly sorted were removed after weighing the bins, and the amount and types of contaminants were recorded.

**Results:** Pre and post intervention participation and contamination rates were compared; both consisting of two weeks worth of measurements. Participation rates were found by summing the contents of each bin types contents over a one-week period, divided by the number of people in the building and then multiplied by 100. Contamination rates were found by dividing the participation results by the number of contaminants for that week (See Appendix E - Figure 3). Our group conducted both ANOVA and t-tests to determine the significance of the findings from our study. Our ANOVA test dealt with different sample sizes for the pre and post conditions, causing our results to have low power. Due to this low power, we have interpreted the findings of our t-tests as the primary significant results of the study.

***Organics:*** The participation in building 1 was 21.46 kg before the intervention and 37.78 kg after the intervention, $p$ = .051. In building 4, participation was 16.43 kg before the intervention and 20.74 kg after the intervention, $p$ = .423. In building 5, participation was 19.81 kg before the intervention and 42.29 kg after the intervention, $p$ = .040.The contamination rate in building 1 pre-intervention was 7.05 kg/contaminant and 4.35 kg/contaminant after the intervention, $p$ = .432. In building 4, contamination rate was 3.61 kg /contaminant before the intervention and 6.10 kg/contaminant after the intervention, $p$ = .398. In building 5, contamination rate was 3.52 kg/contaminant before the intervention and 10.83 kg/contaminant after the intervention, $p$ = .208. A two-way ANOVA was conducted that examined the effect of time and building number on participation in organic composting. There were no statistically significant interactions between the effects of time and building on participation in organic composting [$F$(2,15) = .822, $p$ = .458]. A two-way ANOVA was conducted that examined the effect of time and building number on contamination rate in organic composting. There was a statistically significant interaction between the effects of time and building on contamination rate in organic composting [$F$(2,15) = .3.837, $p$ = .045].

***Containers:*** Building 1 pre-intervention participation was 16.40 kg, while post-intervention participation was 16.46 kg, $p$ = .997. In building 4, pre intervention participation was 20.34 kg; post intervention participation was 16.23 kg, $p$ = .684. Building 5 had a pre-intervention participation of 34.33 kg; and 15.78 kg post intervention, $p$ = .369. Contamination rate of containers were as follows: Building 1 pre-intervention was .80 kg/contaminant; post intervention was 1.42 kg/contaminant. The $t$-test resulted in $p$ = .633. Building 4 measured 1.96 kg/contaminant pre intervention, and .86 kg/contaminant post intervention, with a resulting $p$ = .513. In building 5, pre intervention was 2.20 kg/contaminant while post intervention was .37 kg/contaminant. $p$ = .286. A two-way ANOVA was conducted that examined the effect of time and building number on participation in container recycling. There were no statistically significant interactions between the effects of time and building on participation in container recycling [$F$(2,15) = .257, $p$ = .777]. A two-way ANOVA was conducted that examined the effect of time and building number on contamination rate in container recycling. There were no statistically significant interactions between the effects of time and building on contamination rate in container recycling [$F$(2,15) = 1.447, $p$ = .266].

***Paper:*** The participation results for paper recycling were as follows: Building 1 pre intervention: 9.04kg; post intervention: 10.06 kg; $p$ = .900. Building 4 pre intervention: 22.64 kg; post intervention: 7.02 kg; $p$ = .259. Building 5 pre intervention: 20.87 kg; post intervention: 8.34 kg; $p$ = .394. Contamination rates of paper were as follows: Building 1 pre intervention: 1.04 kg/contaminant; post intervention: 2.50 kg/contaminant; $p$ = .509. Building 4 pre intervention: 1.76 kg/contaminant; post intervention: 1.07 kg/contaminant; $p$ = .606. Building 5 pre intervention: 1.06 kg/contaminant; pre intervention: .25 kg/contaminant; $p$ = .335.A two-way ANOVA was conducted that examined the effect of time and building number on participation in paper recycling. There were no statistically significant interactions between the effects of time and building on participation in paper recycling [$F$(2,15) = .422, $p$ = .663]. A two-way ANOVA was conducted that examined the effect of time and building number on contamination rates in paper recycling. There were no statistically significant interactions between the effects of time and building on contamination rates in paper recycling [$F$(2,15) = .150, $p$ = .862].

**Discussions:**

Vancouver has been acknowledged as one of the greenest cities in the world, yet encouraging individuals to accurately sort their waste has still been an ongoing challenge (Tamanini, 2014). If exposure to both an online waste sorting game and 3D displays can significantly improve waste sorting behaviour, these strategies can be implemented by UBC sustainability to help reach its goal of increasing the recycling rate on campus to 80% by 2020 (West Action Plan, n.d.).

***Organics:*** Tower five showed an improvement in organic participation that was statistically significant. This finding may have been significant due to the high weight of compostable items making this measure particularly sensitive. Tower one showed an increase in participation and a decrease in contamination, but neither was statistically significant.

***Containers:*** Tower one showed a minimal difference in participation, while tower five had a large drop in participation. Tower one increased in contamination rates, while tower five decreased in contamination rates. The decrease of participation and contamination rates in tower five could be a result of less contaminants being incorrectly sorted, which we view most positively than seeing an increase in participation and an increase in contamination rates. None of the results were significant.

***Paper***: Tower one had a minimal increase in participation while tower five had a large drop in participation. At the same time, tower one had an increase in contamination rate while tower five had a large drop in contamination. Again, this could point to residents in tower five sorting waste more accurately, and the drop in participation could be a result of less contaminants being incorrectly sorted.The variability in participation and contamination in tower four, the control condition, speaks to the low power of our ability to claim that changes in towers one and five were due to the engagement strategies, rather than typical fluctuations between weeks. None of the results were significantly significant.

***Limitations:*** The independent variables of the online sorting game and 3D displays may not have had enough of an effect to elicit a difference in the waste sorting behaviour of the intervention groups. This may have made it difficult to remember any particular item as they were exposed to so much new material. The 3D displays in tower one have been in place for over a year and residents may have become habituated to them. These displays may have lost their intervention power before the onset of our study. Because contamination rates were low overall, a single person depositing a large amount of contaminants could have skewed the data for an entire day or even an entire week. We occasionally discovered a large quantity of contaminants in one bin even though inspections of the other bins of the same type and tower location were relatively clean. Although one could assume a single user placed the large amount of contaminants in that bin, the experimenters can not discard this data as it may have been many users contributing to the contaminants of that single bin. This allowed a single user to potentially upset the contamination ratio for that day, even when everyone else in the building may have been sorting correctly. We found large variation in the weights of the empty recycling bins, a variation that sometimes exceeded the measurements for that bin. The bins varied by .7 of a kilogram, which is about one and a half pounds. Many measurements were in the ballpark of one and a half pounds and a bin full of empty pop cans weighs less than this natural variation. A small number of students played the game multiple times. Although the sorting bins were visually inspected for contaminants in the same way that the waste disposal staff conduct their checks, inspecting only the uppermost section of the waste contents may have been a poor representation of the true contaminant levels within the bins. It is possible that the top of the bin may have been contaminant free while the bottom of the bin contained many contaminants or vice-versa.

**Recommendations for your client:** We recommend making the online game more salient to the students by reducing the number of incorrect items that the students are exposed to, and instead focusing on deeply ingraining a small number of commonly missorted items. Most students scored below 70% accuracy in the game and so were exposed to more than 9 corrections during their game play. Rather than exposing each student to multiple corrections and expecting them to memorize the proper bins in which to place nine or ten different items, a future project should focus on making sure that each student who plays the game walks away with a greater understanding of the proper disposal of two or three items. By targeting only a couple of unfamiliar items, and repeating these items across several questions, we can ensure that participants are not cognitively overwhelmed by the game and that they remember each correction for a longer period of time, hopefully acting upon this new knowledge. Another suggestion for the clients might be to divide the online sorting game into two parts, a learning phase and testing phase. The learning phase can consist of either educating participants what should be and shouldn't be thrown into each bin, or showing examples of what goes into each bin. The testing phase can look exactly like the current sorting game, but with fewer items. It might also be a good idea to include in the testing phase the very same waste items that were shown to students in the learning phase. This would increase the game's saliency to students because of repeated exposure to the waste items.

The clients should consider a double-blind study instead of the current format, so biases between buildings can be alleviated and the possibility of experimenter bias affecting results can be avoided. We recommend that the empty bins be measured and their weights permanently labeled, allowing more accurate measurements of contents. Research has shown that pro-environmental behaviour such as proper waste sorting efficacy is affected by external reasoning such as convenience, financial considerations as well as social norms surrounding the behaviour (Thomas et al. 2013, Clark et al. 2003). Although there are four different types of bins in the common waste disposal area, most residents only have a single waste bin in their rooms. Residents are unlikely to dig through their single bin and sort each waste item into the appropriate bins once in the common area. We suggest supplying the rooms with each type of waste bin so that sorting can take place where the waste is being produced. The contents of the 3D displays should also be changed frequently, perhaps once a week or every other week. Participants will stop looking at and learning from the 3D displays if they have grown accustomed to it. Making sure the 3D displays continue to educate and affect waste sorting behaviour is important for meaningful results. Alternatively, in an effort to increase waste sorting accuracy, a 3D display of prohibited items hanging above every bin could help students to avoid depositing commonly misplaced items into the incorrect bins.

References


Barsade, S. G. (2002). The Ripple Effect: Emotional Contagion and Its Influence on Group Behavior. *Administrative Science Quarterly*. 47: 644-675.

Clark, C. F., Kotchen, M. J., & Moore M. R. (2003). Internal and external influences on pro-environmental behavior: Participation in a green electricity program. *Journal of Environmental Psychology*. 23(3): 237-246.

John, P., Smith, G., & Stoker, G. (2009). Nudge nudge, think think: Two strategies for changing civic behaviour. *Political Quarterly,80*(3), 361-370. doi:10.1111/j.1467-923X.2009.02001.x

Tamanini, J. (2014). The Global Green Economy Index - 2014. *Dual Citizen LLC*. 1-49.

Thomas, C. & Sharp, V. (2013). Understanding the normalisation of recycling behaviour and its implications for other pro-environmental behaviours: a review of social norms and recycling . *Resources, Conservation and Recycling.* 79: 11-20.

Waste Action Plan. (n.d.). Retrieved April 07, 2016, from https://sustain.ubc.ca/campus-initiatives/recycling-waste/what-ubc-doing/waste-action-plan

# Appendix A

Figure A1: Screenshot of the online waste sorting game's home page

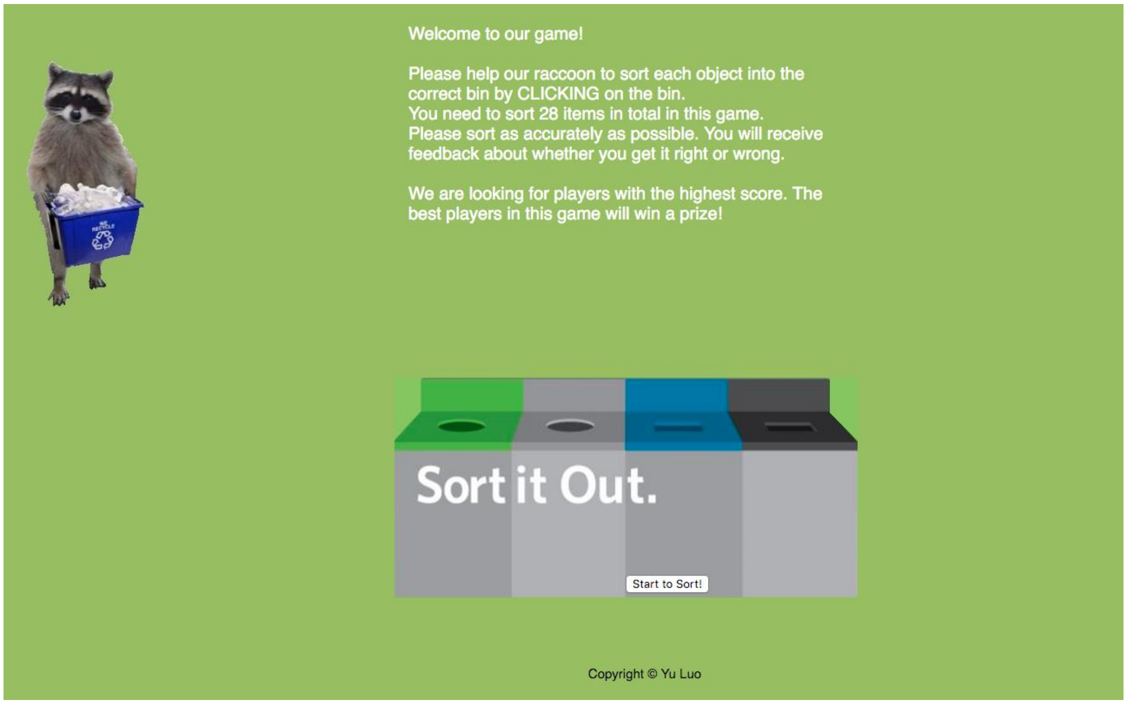
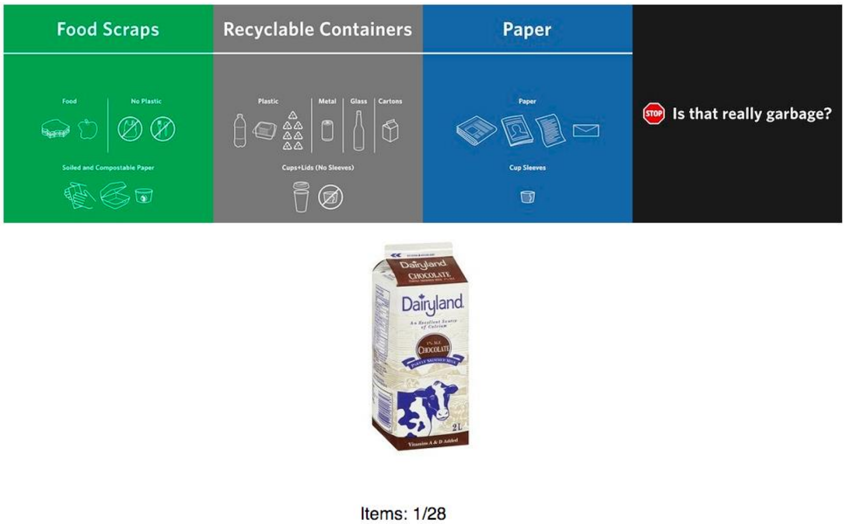



Figure A2: Screenshot of the in-game play. Participants must select the appropriate bin to place the waste into



Appendix B

Figure B1: Screenshot of the feedback given during the online game when participants sort the waste item into the appropriate bin

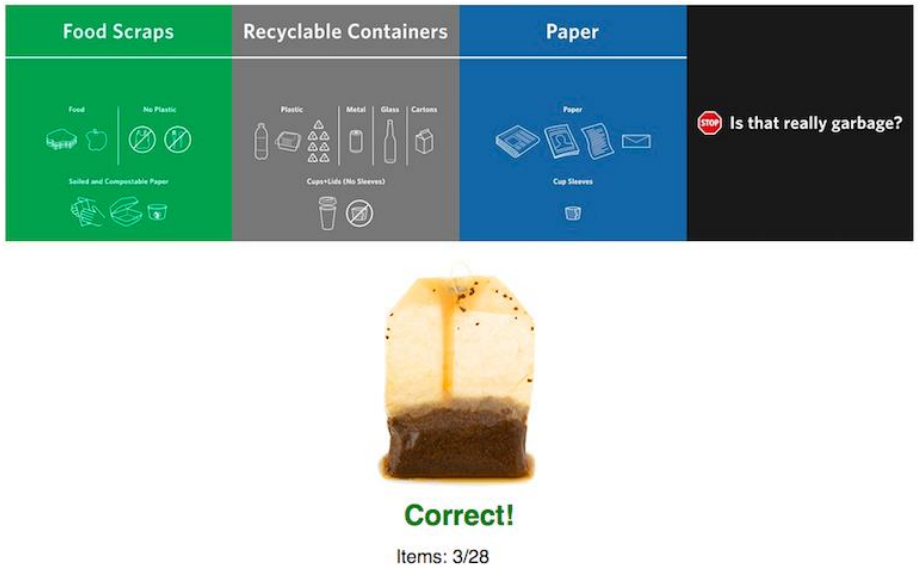
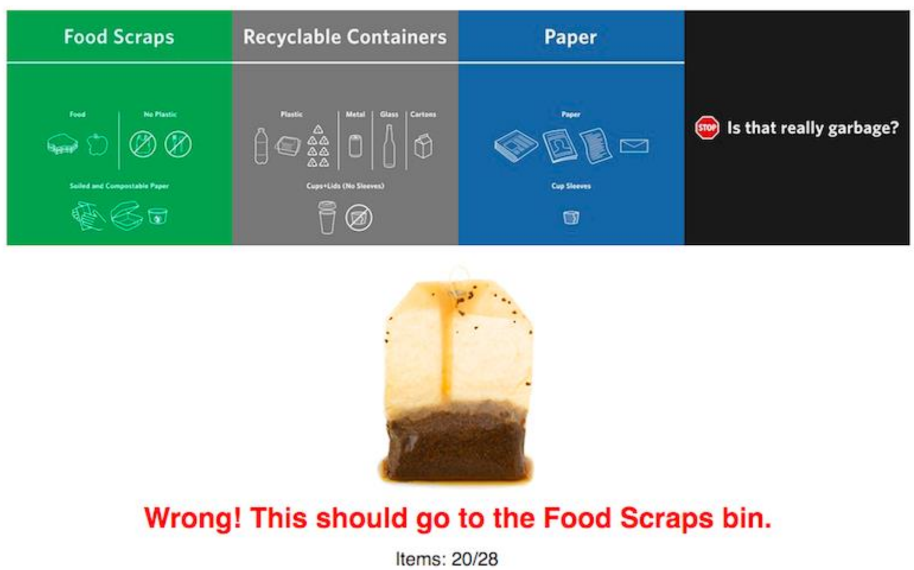
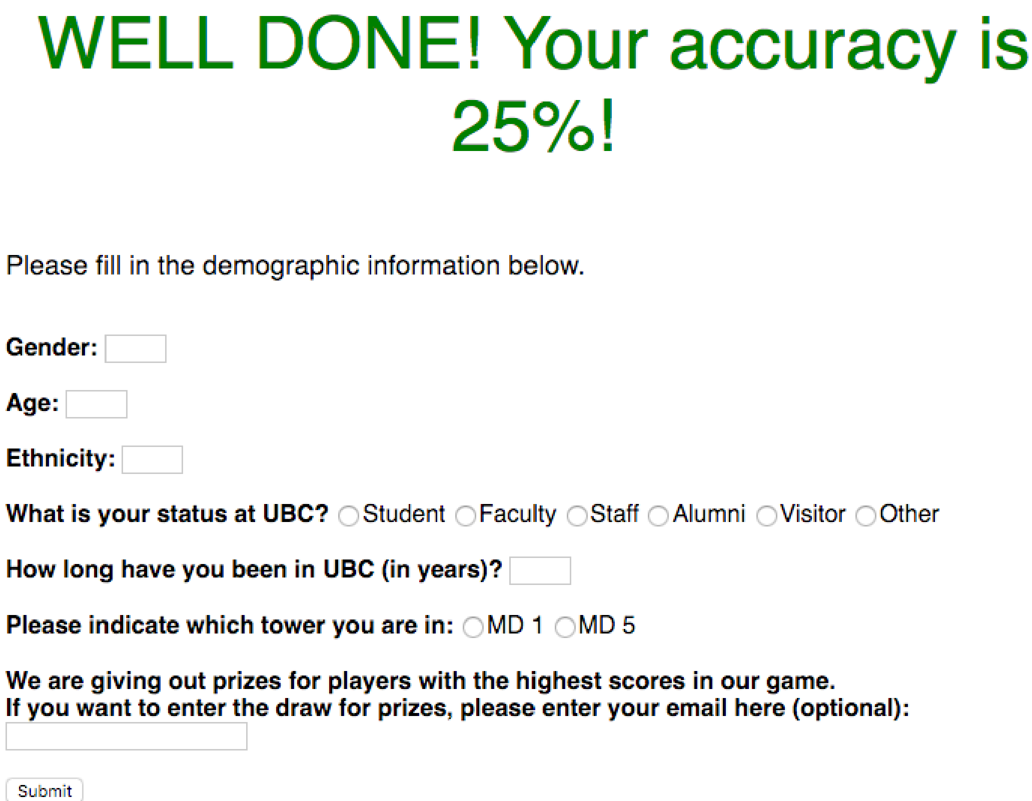



Figure B2: Screenshot of feedback given during the online game when participants sort the waste item into the inappropriate bin



Appendix C

Figure C1: Screenshot of the demographic questionnaire page with the participant's accuracy percentage



WELL DONE! Your accuracy is 25%!

Please fill in the demographic information below.

**Gender:**

**Age:**

**Ethnicity:**

**What is your status at UBC?** ○ Student ○ Faculty ○ Staff ○ Alumni ○ Visitor ○ Other

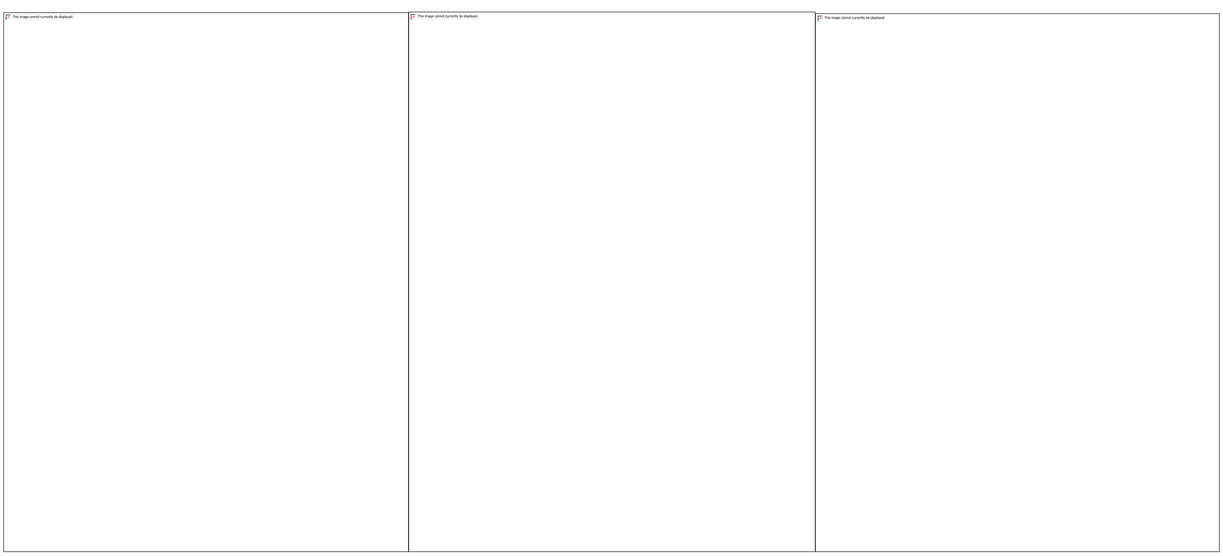
**How long have you been in UBC (in years)?**

**Please indicate which tower you are in:** ○ MD 1 ○ MD 5

**We are giving out prizes for players with the highest scores in our game.**
**If you want to enter the draw for prizes, please enter your email here (optional):**

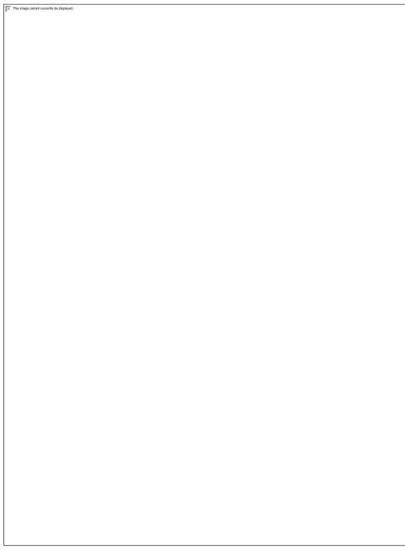
Submit

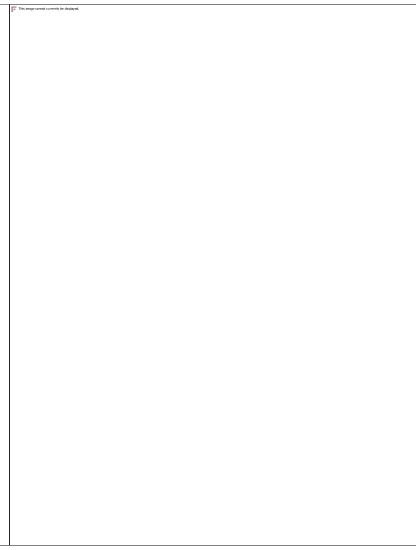
Figure C2: 3D displays posted above the recyclable containers, food scraps, and paper bins in tower one



Appendix D

Figure D1: Waste bins in tower one with the 3D displays.



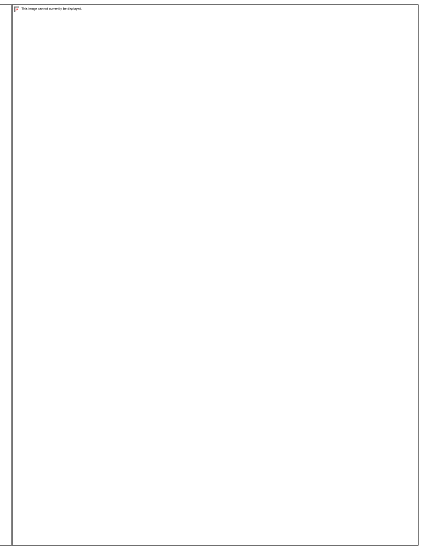
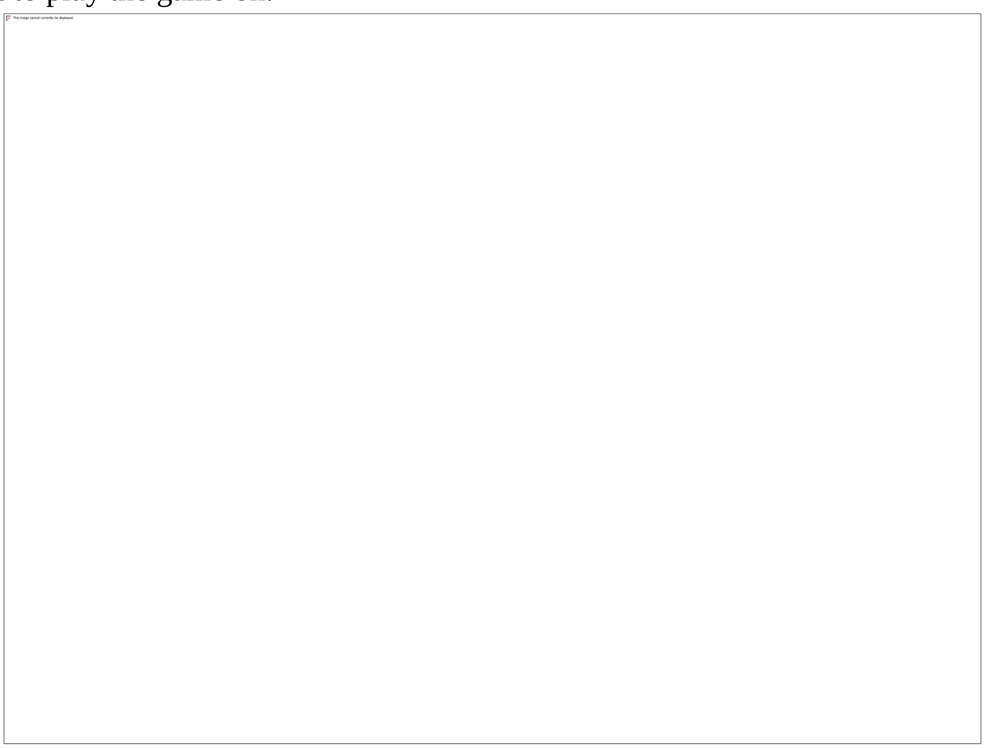




Figure D2: The student engagement sessions booth. Posters for the sorting game, chocolate as a participation incentive, an iPad that participants can play the game on, and a laptop for a second participant to play the game on.



Appendix E

Figure E1: One of the posters hung inside the Marine Drive residences to promote the game

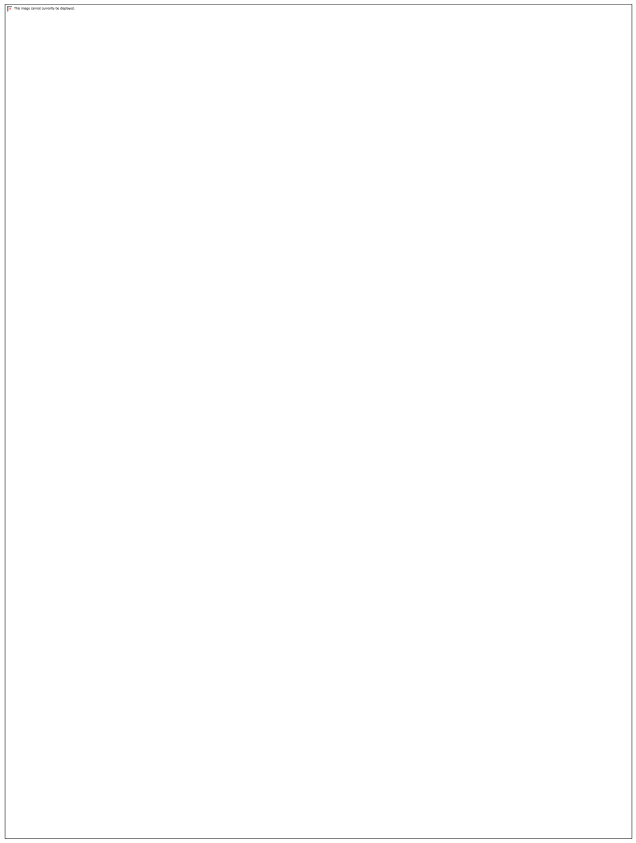


Figure E2: Screenshot of the Marine Drive data sheet

| Date | Bin Type | Weight Kg | Kg of Materials 2 Kg recycling b | # of Contaminents | Soft Plastics | Containers | Napkins | Other |
|---|---|---|---|---|---|---|---|---|
| Visit 1 | Organics | 34.8 | 22.80 | 2 | 2 | | | 1 compostable |
| Visit 2 | Organics | 27.6 | 15.60 | 1 | 1 | | | |
| Visit 3 | Organics | 39.8 | 27.80 | 2 | 1 | | | 1 styrofoam |
| | | | 66.20 | 5.00 | | | | |

Figure E3: Table of pre-intervention and post-intervention p-values

| Bin Type, Dependent variable | Building | Pre-intervention | Post-intervention | *p* |
|---|---|---|---|---|
| Organics, Participation (kg) | 1 | 21.46 | 37.78 | .051 |
| | 4 | 16.43 | 20.74 | .423 |
| | 5 | 19.81 | 42.29 | .040* |
| Organics, Contamination rate | 1 | 7.05 | 4.35 | .423 |

| | | | | |
|---|---|---|---|---|
| (kg/contaminant) | | | | |
| | 4 | 3.61 | 6.10 | .398 |
| | 5 | 3.52 | 10.83 | .208 |
| Containers, Participation (kg) | 1 | 16.40 | 16.46 | .997 |
| | 4 | 20.34 | 16.23 | .684 |
| | 5 | 34.33 | 15.78 | .369 |
| Containers, Contamination rate (kg/contaminant) | 1 | .80 | 1.42 | .633 |
| | 4 | 1.96 | .86 | .513 |
| | 5 | 2.20 | .37 | .286 |
| Paper, Participation (kg) | 1 | 9.04 | 10.06 | .900 |
| | 4 | 22.64 | 7.02 | .259 |
| | 5 | 20.87 | 8.34 | .394 |
| Paper, Contamination rate (kg/contaminant) | 1 | 1.04 | 2.50 | .509 |
| | 4 | 1.76 | 1.07 | .606 |
| | 5 | 1.06 | .25 | .335 |

Appendix F

Figure F1: Graph of Tower 1 organics participation over time. Weight is calculated as KG's per student per day multiplied by 100

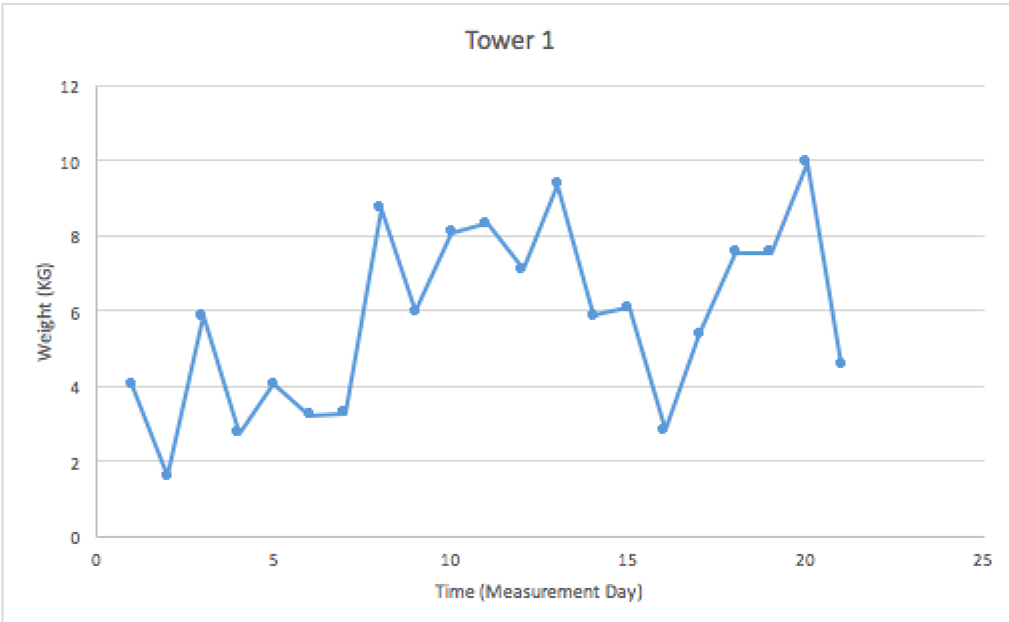
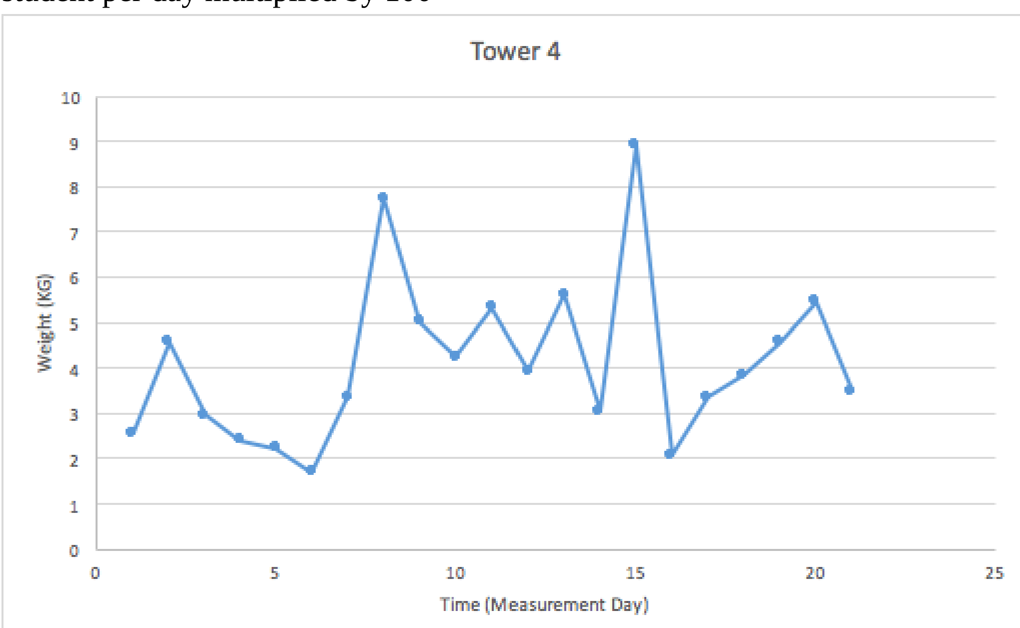



Figure F2: Graph of Tower 4 organics participation over time. Weight is calculated as KG's per student per day multiplied by 100



Appendix G

Figure G1: Graph of Tower 5 organic participation over time. Weight is calculated as KG's per student per day multiplied by 100

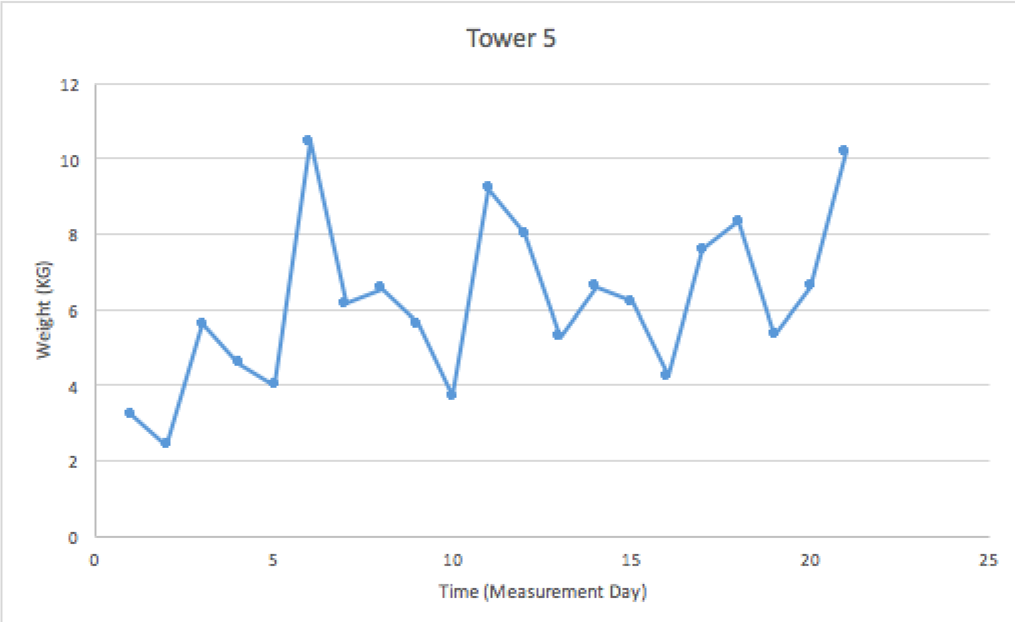
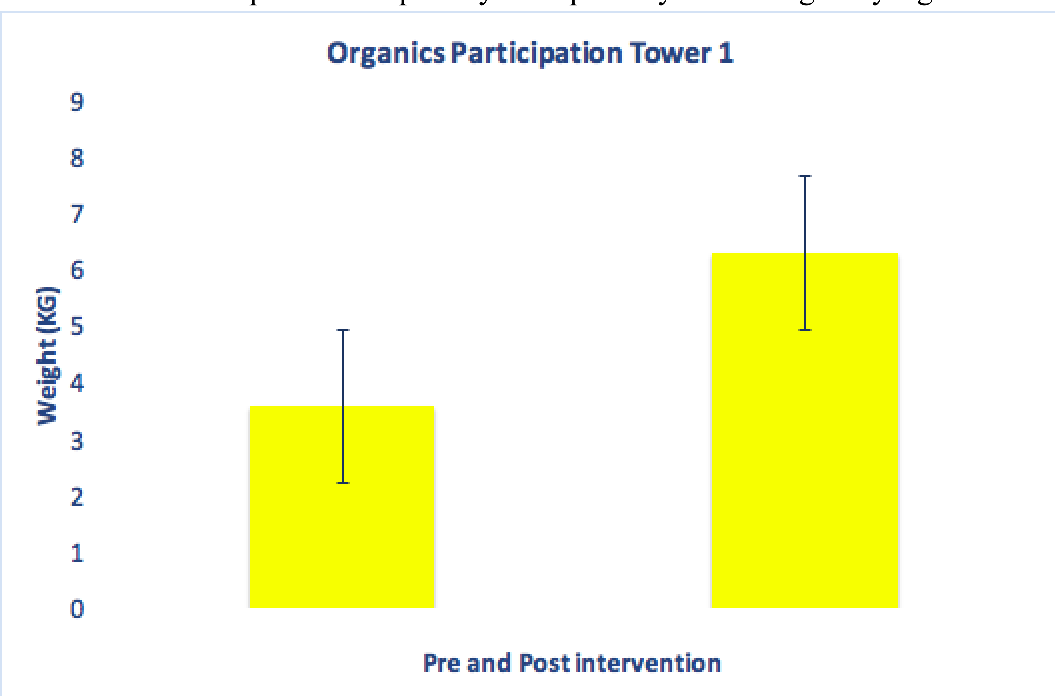



Figure G2: Graph of Tower 1 organics participation pre and post intervention. Weight is calculated as KG's per student per day multiplied by 100. Marginally significant.



Appendix H

Figure H1: Graph of Tower 4 organics participation pre and post intervention. Weight is calculated as KG's per student per day multiplied by 100. Not significant.

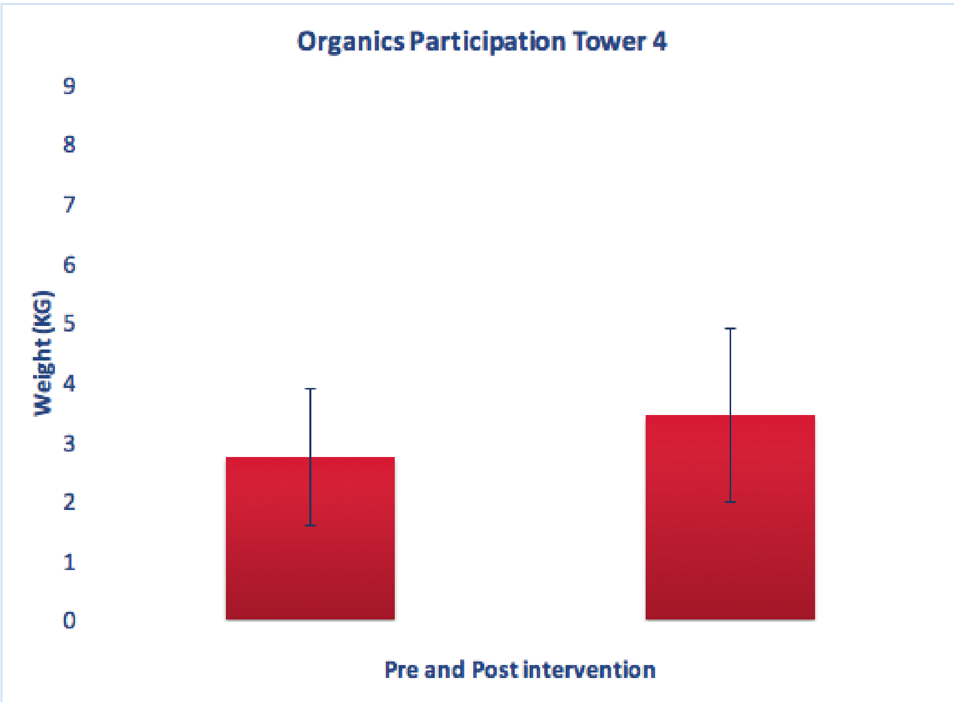
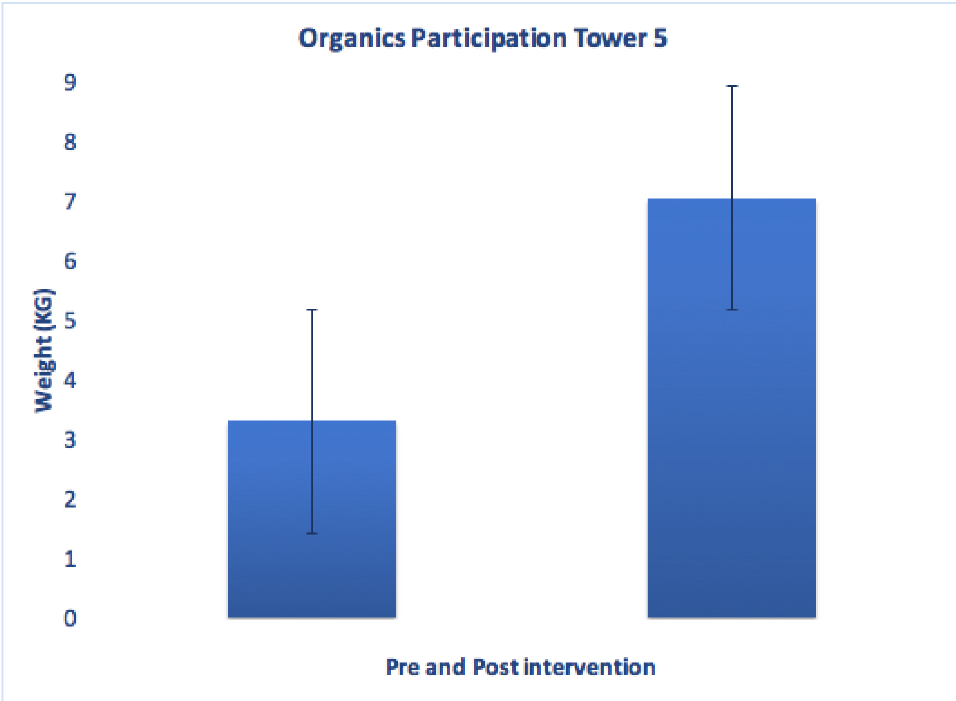



Figure H2: Graph of Tower 5 organics participation pre and post intervention. Weight is calculated as KG's per student per day multiplied by 100. Significant at $p<.05$.


Organics Participation Tower 5
Weight (KG)
0
1
2
3
4
5
6
7
8
9
Pre and Post intervention

Appendix I

Figure I1: Table of within-subjects effects for Organic participation. Tests of Within-Subjects Effects table tells us if there was an overall significant difference between the means at the different time points.

**Tests of Within-Subjects Effects**

Measure: OrgKgAdj

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | 35.359 | 1 | 35.359 | 4.345 | .055 | .225 |
| | Greenhouse-Geisser | 35.359 | 1.000 | 35.359 | 4.345 | .055 | .225 |
| | Huynh-Feldt | 35.359 | 1.000 | 35.359 | 4.345 | .055 | .225 |
| | Lower-bound | 35.359 | 1.000 | 35.359 | 4.345 | .055 | .225 |
| Time * Building | Sphericity Assumed | 13.379 | 2 | 6.690 | .822 | .458 | .099 |
| | Greenhouse-Geisser | 13.379 | 2.000 | 6.690 | .822 | .458 | .099 |
| | Huynh-Feldt | 13.379 | 2.000 | 6.690 | .822 | .458 | .099 |
| | Lower-bound | 13.379 | 2.000 | 6.690 | .822 | .458 | .099 |
| Error(Time) | Sphericity Assumed | 122.059 | 15 | 8.137 | | | |
| | Greenhouse-Geisser | 122.059 | 15.000 | 8.137 | | | |
| | Huynh-Feldt | 122.059 | 15.000 | 8.137 | | | |
| | Lower-bound | 122.059 | 15.000 | 8.137 | | | |

Figure I2: Table of between-subjects effects for Organic participation

**Tests of Between-Subjects Effects**

Measure: OrgKgAdj

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 634.012 | 1 | 634.012 | 189.269 | .000 | .927 |
| Building | 16.722 | 2 | 8.361 | 2.496 | .116 | .250 |
| Error | 50.247 | 15 | 3.350 | | | |

Appendix J

Figure J1: Table of within-subjects effects for Organic contamination rate

**Tests of Within-Subjects Effects**

Measure: OrgContam

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | 195.083 | 1 | 195.083 | 4.228 | .058 | .220 |
| | Greenhouse-Geisser | 195.083 | 1.000 | 195.083 | 4.228 | .058 | .220 |
| | Huynh-Feldt | 195.083 | 1.000 | 195.083 | 4.228 | .058 | .220 |
| | Lower-bound | 195.083 | 1.000 | 195.083 | 4.228 | .058 | .220 |
| Time * Building | Sphericity Assumed | 354.104 | 2 | 177.052 | 3.837 | .045 | .338 |
| | Greenhouse-Geisser | 354.104 | 2.000 | 177.052 | 3.837 | .045 | .338 |
| | Huynh-Feldt | 354.104 | 2.000 | 177.052 | 3.837 | .045 | .338 |
| | Lower-bound | 354.104 | 2.000 | 177.052 | 3.837 | .045 | .338 |
| Error(Time) | Sphericity Assumed | 692.089 | 15 | 46.139 | | | |
| | Greenhouse-Geisser | 692.089 | 15.000 | 46.139 | | | |
| | Huynh-Feldt | 692.089 | 15.000 | 46.139 | | | |
| | Lower-bound | 692.089 | 15.000 | 46.139 | | | |

**Tests of Between-Subjects Effects**

Measure: OrgContam

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 1790.18 | 1 | 1790.18 | 23.523 | .000 | .611 |
| Building | 155.933 | 2 | 77.966 | 1.024 | .383 | .120 |
| Error | 1141.54 | 15 | 76.103 | | | |

Figure J2: Table of between-subjects effects for Organic contamination rate

## Appendix K

Figure K1: Table of within-subjects effects for Container participation

**Tests of Within-Subjects Effects**

Measure: ContainersAdj

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | .543 | 1 | .543 | .058 | .813 | .004 |
| | Greenhouse-Geisser | .543 | 1.000 | .543 | .058 | .813 | .004 |
| | Huynh-Feldt | .543 | 1.000 | .543 | .058 | .813 | .004 |
| | Lower-bound | .543 | 1.000 | .543 | .058 | .813 | .004 |
| Time * Building | Sphericity Assumed | 4.821 | 2 | 2.411 | .257 | .777 | .033 |
| | Greenhouse-Geisser | 4.821 | 2.000 | 2.411 | .257 | .777 | .033 |
| | Huynh-Feldt | 4.821 | 2.000 | 2.411 | .257 | .777 | .033 |
| | Lower-bound | 4.821 | 2.000 | 2.411 | .257 | .777 | .033 |
| Error(Time) | Sphericity Assumed | 140.659 | 15 | 9.377 | | | |
| | Greenhouse-Geisser | 140.659 | 15.000 | 9.377 | | | |
| | Huynh-Feldt | 140.659 | 15.000 | 9.377 | | | |
| | Lower-bound | 140.659 | 15.000 | 9.377 | | | |

Figure K2: Table of between-subjects effects for Container participation

**Tests of Between-Subjects Effects**

Measure: ContainersAdj

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 527.008 | 1 | 527.008 | 18.851 | .001 | .557 |
| Building | 59.729 | 2 | 29.864 | 1.068 | .368 | .125 |
| Error | 419.351 | 15 | 27.957 | | | |

Appendix L

Figure L1: Table of within-subjects effects for Container contamination rate

**Tests of Within-Subjects Effects**

Measure: ContainerContaminationRate

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | .175 | 1 | .175 | .067 | .799 | .004 |
| | Greenhouse-Geisser | .175 | 1.000 | .175 | .067 | .799 | .004 |
| | Huynh-Feldt | .175 | 1.000 | .175 | .067 | .799 | .004 |
| | Lower-bound | .175 | 1.000 | .175 | .067 | .799 | .004 |
| Time * Building | Sphericity Assumed | 7.560 | 2 | 3.780 | 1.447 | .266 | .162 |
| | Greenhouse-Geisser | 7.560 | 2.000 | 3.780 | 1.447 | .266 | .162 |
| | Huynh-Feldt | 7.560 | 2.000 | 3.780 | 1.447 | .266 | .162 |
| | Lower-bound | 7.560 | 2.000 | 3.780 | 1.447 | .266 | .162 |
| Error(Time) | Sphericity Assumed | 39.191 | 15 | 2.613 | | | |
| | Greenhouse-Geisser | 39.191 | 15.000 | 2.613 | | | |
| | Huynh-Feldt | 39.191 | 15.000 | 2.613 | | | |
| | Lower-bound | 39.191 | 15.000 | 2.613 | | | |

Figure L2: Table of between-subjects effects for Container contamination rate

**Tests of Between-Subjects Effects**

Measure: ContainerContaminationRate

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 90.021 | 1 | 90.021 | 7.310 | .016 | .328 |
| Building | 16.677 | 2 | 8.339 | .677 | .523 | .083 |
| Error | 184.731 | 15 | 12.315 | | | |

# Appendix M

Figure M1: Table of within-subjects effects for paper participation

**Tests of Within-Subjects Effects**

Measure: PaperKgAdjusted

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | 6.389 | 1 | 6.389 | .551 | .469 | .035 |
| | Greenhouse-Geisser | 6.389 | 1.000 | 6.389 | .551 | .469 | .035 |
| | Huynh-Feldt | 6.389 | 1.000 | 6.389 | .551 | .469 | .035 |
| | Lower-bound | 6.389 | 1.000 | 6.389 | .551 | .469 | .035 |
| Time * Building | Sphericity Assumed | 9.797 | 2 | 4.899 | .422 | .663 | .053 |
| | Greenhouse-Geisser | 9.797 | 2.000 | 4.899 | .422 | .663 | .053 |
| | Huynh-Feldt | 9.797 | 2.000 | 4.899 | .422 | .663 | .053 |
| | Lower-bound | 9.797 | 2.000 | 4.899 | .422 | .663 | .053 |
| Error(Time) | Sphericity Assumed | 174.024 | 15 | 11.602 | | | |
| | Greenhouse-Geisser | 174.024 | 15.000 | 11.602 | | | |
| | Huynh-Feldt | 174.024 | 15.000 | 11.602 | | | |
| | Lower-bound | 174.024 | 15.000 | 11.602 | | | |

Figure M2: Table of between-subjects effects for paper participation

**Tests of Between-Subjects Effects**

Measure: PaperKgAdjusted

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 224.594 | 1 | 224.594 | 15.580 | .001 | .509 |
| Building | 25.506 | 2 | 12.753 | .885 | .433 | .106 |
| Error | 216.233 | 15 | 14.416 | | | |

Appendix N

Figure N1: Table of within-subjects effects for paper contamination rate

**Tests of Within-Subjects Effects**

Measure: PaperContaminationRate

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Time | Sphericity Assumed | 6.136 | 1 | 6.136 | 4.195 | .058 | .219 |
| | Greenhouse-Geisser | 6.136 | 1.000 | 6.136 | 4.195 | .058 | .219 |
| | Huynh-Feldt | 6.136 | 1.000 | 6.136 | 4.195 | .058 | .219 |
| | Lower-bound | 6.136 | 1.000 | 6.136 | 4.195 | .058 | .219 |
| Time * Building | Sphericity Assumed | .439 | 2 | .220 | .150 | .862 | .020 |
| | Greenhouse-Geisser | .439 | 2.000 | .220 | .150 | .862 | .020 |
| | Huynh-Feldt | .439 | 2.000 | .220 | .150 | .862 | .020 |
| | Lower-bound | .439 | 2.000 | .220 | .150 | .862 | .020 |
| Error(Time) | Sphericity Assumed | 21.939 | 15 | 1.463 | | | |
| | Greenhouse-Geisser | 21.939 | 15.000 | 1.463 | | | |
| | Huynh-Feldt | 21.939 | 15.000 | 1.463 | | | |
| | Lower-bound | 21.939 | 15.000 | 1.463 | | | |

Figure N2: Table of between-subjects effects for paper contamination rate

**Tests of Between-Subjects Effects**

Measure: PaperContaminationRate

Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 27.665 | 1 | 27.665 | 14.259 | .002 | .487 |
| Building | 2.121 | 2 | 1.060 | .547 | .590 | .068 |
| Error | 29.102 | 15 | 1.940 | | | |