Waste Knowledgeability on Studley Campus

SUST/ENVS 3502: Environmental Problem Solving II: The Campus as a Living Laboratory, Final Report, April 10th 2018

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1. Executive Summary

Waste being sorted improperly around Dalhousie University's Studley campus is an obvious issue. Improper sorting methods on campus can account for thousands of pounds of contaminated waste ending up in landfills every year, and this costs the university in unnecessary landfill fees. This is why our group decided to conduct our research project on the Dalhousie populations knowledgeability of proper waste sorting guidelines, asking the question "has the population on Dalhousie University's Studley campus been educated on how to properly dispose of waste according to the Halifax municipal waste guidelines and how does this translate into their actual sorting habits?" To test what the population thinks they know about the waste sorting guidelines, we created a survey (Appendix A.) and advertised it via poster (Appendix B.) through four staple Studley campus buildings. To determine what the population really knew, we conducted a waste audit of those same buildings and measured the amount of waste being thrown out and compared it to the amount of contaminant waste that was pulled from each bag. We found that contaminants were being disproportionately thrown into the garbage bin and that over 18% of all waste we collected was put into the wrong receptacle. Comparing this to our qualitative survey results, we discovered that over 80% of our participants claimed to be knowledgeable of the Halifax Regional Municipality (HRM) waste sorting guidelines and did not find them confusing. This indicates to us that a knowledge gap exists between what the Dalhousie population thinks they know about sorting their waste and what they actually know. We found the majority of people support modifications to the Dalhousie waste sorting program, and identified that people would be most likely to benefit from additional posters around the buildings of particularly hard to sort waste items with new sorting items that were area specific, such as Subway wrappers in the Killam, or Pizza Pizza boards in the Life Sciences Centre (LSC).

2. Introduction

2.1. Solid Waste on a Global Scale

How solid waste is managed is critical to the health of the environment and people. The lowering of greenhouse gas (GHG) emissions is an important mitigation strategy to combat climate change, and landfills, the disposal sites for most types of solid waste, produce GHG's such as carbon dioxide and methane (Jha et al., 2007). In 2015, landfills in Canada emitted approximately 19 Mt eCO2 and released 20% of Canada's national methane emissions (Government of Canada, 2017). Emissions can be lowered when source-segregated waste is recycled (Turner, Williams & Kemp, 2015), hence, proper waste disposal and diversion is important. The management of solid waste is therefore an area of critical importance and there remains room for improving solid waste management and increasing waste diversion rates.

2.2. Nova Scotia and Dalhousie University's Targets

Nova Scotia is a leader and innovator in solid waste management. The province achieved an ambitious diversion rate of 50% in 2000, and set a new goal of 300 kg of waste per person per year by 2015 (Nova Scotia Environment, 2011). The new target has yet to be achieved, however, new strategies and systems are continually being put into place to try to reach this goal. Similarly, institutions across Nova Scotia have their own solid waste management strategies to reach targets of their own and to contribute to the overall reduction of waste in Nova Scotia. Dalhousie University has a *Solid Waste Management Plan* in place. The goal is to reach a 70% diversion rate by 2020 and to reduce the weight of waste generated per campus user (Dalhousie University Office of Sustainability, 2015). Reaching this goal requires education and collaboration across Dalhousie Campus. Students must be

aware and committed to following the Halifax Regional Municipality Waste Guidelines, and waste sorting on campus must be clear and accessible to students.

2.3. The Purpose and Goals of our Study

The purpose of our research project is to understand the level of waste sorting education that students on Dalhousie University's Studley campus have and subsequently, if they use this knowledge in their daily waste disposal habits. The relationship between the knowledge people have of sorting and their translated habits is an area of importance to study as people's understanding of waste sorting does not necessarily translate to their actions (Bernstad, 2014). This study will examine this issue on Studley Campus and aim to understand why proper sorting does not always occur. By understanding knowledge as well as habits, we can attempt to determine drivers behind sorting habits – do individuals require further education on these guidelines, or is something else required to motivate proper sorting? We also wish to identify if the Halifax Municipal Waste Guidelines are clear to students and if there are ways students on campus feel the four-bin waste system could be improved to increase proper waste disposal. Overall, by identifying limitations in the waste education and knowledge of students we hope to be able to recognize ways in which we can improve waste diversion rates on campus to work towards a more sustainable future.

3. Methods

3.1. Description

Qualitative Tool: Online Survey

An internet-based survey was used to gather data for the analysis of participants' knowledge related to waste sorting and the waste-sorting education they received. The online survey was chosen as our qualitative research tool due to its advantages of being low cost and

less time-consuming (Wright, 2005). The survey was self-administered and confidential, participation was voluntary according to respondents' interests to the topic. The participants of the survey were mostly recruited by putting posters on display boards in four buildings on campus with the most foot traffic; these buildings included the Life Science Centre (LSC), Student Union Building (SUB), Killam Memorial Library, and Marion McCain Arts and Social Sciences Building. The research topic, research purpose, survey prize, survey link, QR code, sponsor, and all necessary details are included in the poster as shown in Appendix B. Some printed strips with the survey link were also handed out to recruit participants in multiple locations (Appendix C).

The online survey was open from March 13 to March 27. The target sample size of the survey was n = 376 (Survey system, n.d.) with the Dalhousie population of ~19,000 (Dalhousie University, n.d.), a confidence interval of 95% and a margin of error of 5%. However, by noon of March 27, only 143 responses were collected before the survey was closed. Therefore, the new confidence interval is 90% and the margin of error became 7% (Macorr, n.d.).

In the survey, participants were asked about their understandings of waste sorting, waste sorting habits at home, and thoughts about waste sorting on Dalhousie Campus. At the end of the survey, participants were asked to sort specific waste items like styrofoam, paper towel, plastic wrap, and a coffee cup into the four-bin waste system used on campus (Appendix A). The items above are chosen based on the fact that they are commonly found around campus for food packaging and they were also items that we predicted would be frequently observed during the waste audit.

Quantitative tool: Waste Audit

Quantitative measurement of the waste sorting practices of Dalhousie University students were taken at multiple sites in Studley campus (LSC, SUB, Killam Memorial Library, and Marion McCain Arts and Social Sciences Building) to examine whether the waste-sorting education received by participants translated to their actual sorting habits. During the pilot study, observation was used as a quantitative tool, then the group changed the tool to a waste audit due to the inefficiencies of observation. First, observation is time-consuming and inefficient, less than thirty observations were collected within a one hour duration. Secondly, some waste items were difficult to recognize with visual criteria, and due to some ethical issue, the team was not allowed to ask participants about confusing items. Compared to observation, a waste audit was considered as the best quantitative tool to directly observe the waste items in each bins, and it was chosen due to its advantages of higher efficiency and having less error and confusion.

In order to avoid the potential ethical issue during the waste audit, an REB application was submitted and then approved by the Research Ethics Board. The team contacted facilities management before the audit to ask for their permissions and assistance.

The waste audit was conducted from waste collected from 6 sets of four-bin systems (24 bags of waste items in total) located in the SUB by the Tim Hortons, SUB by the Pete's To Go, LSC near the Tim's, Wallace McCain Learning Commons near the entrance, and the McCain building main floor. Bags of waste items were collected by custodial service, and bags were labeled with waste categories (organics, paper, recycling and garbage) and the location of collection. Each collected labeled bag was weighed, and the weight was recorded. During the waste audit, the waste items in each bag were sorted into two general categories; properly sorted items and contaminants. Contamination was defined as any item that did not belong in the bag according to the Halifax Municipal Waste guidelines. In addition, a count

of all coffee cups found in each bag was done. Properly sorted items and contaminants were then placed in separate bags and weighed. We were then able to compare the total weight of waste in each bag to the weight of contamination found in the bag. See Appendix D for all the data collected during the waste audit. All the waste items collected for the waste audit were properly sorted according to Halifax Municipal waste sorting guideline after the audit.

3.2 Limitations

Online Survey:

We recognize that there are some limitations for the online survey (qualitative research). First, the number of responses collected were much less than the target sample size which is what we needed to get a representative result of the Dalhousie student population. The lack of participants may have resulted from the location chosen for posting the recruitment posters, the posters were only posted in four buildings, thus, a large proportion of the Dalhousie population may have had limited access to the survey. Secondly, the research population is restricted within the Dalhousie population in Studley campus where the waste audits operated, however, no statistics of the Dalhousie population in Studley was found. The population size used for our method was estimated based on the total Dalhousie population which includes the population of Halifax campus and Truro agriculture campus. Thirdly, the authenticity of some responses are questionable given that some responses from the same respondents were inconsistent, and the group suspects that some participants may have participated in the survey multiples times based on the email addresses that were provided for the prize draw.

Waste Audit:

There were two major issues that occurred during the waste audit. The plan with facilities management was to operate the waste audit on bags from ten sets of four-bin systems, however, only six sets of the four-bin systems were recovered because some bags were misplaced by facilities. Secondly, the group noticed a few inconsistencies in weights of the bags when examining the data, which had to be addressed in our data analysis. When adding the weight of the contaminants and weight of properly sorted items, the group found that the result and recorded total weight were not always consistent. The measurement error of the scale is considered as one of the possible cause of the inconsistency on the data. Since all the coffee cups were sorted separately, some coffee cups were probably repeatedly weighed or missing. The misoperation during the waste audit may also contributed to the data inconsistency. As shown in Appendix D, the final total weights ("total (kg)" in table) used for further analysis were recalculated through adding up the weights of properly sorted items and the contamination weights (numbers labeled with "*").

4. Results

Quantitative (Audit) Results

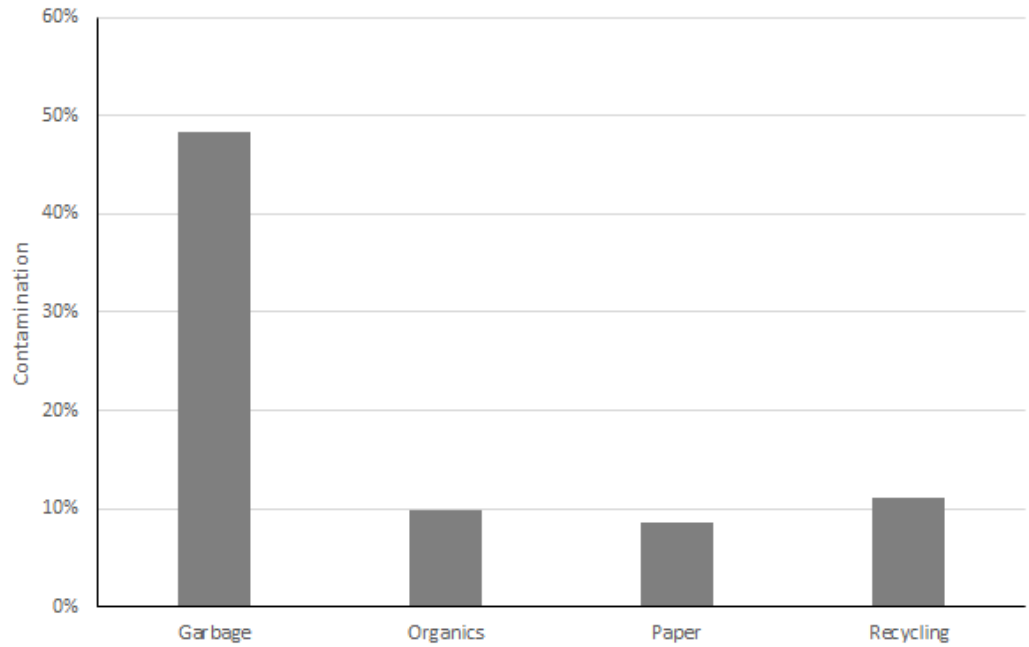

Figure 1: Average contamination per bin type around the Dalhousie University Studly Campus.

Based on the weights of each bag of garbage and the average weights of contamination, there was 48.29% contamination in the garbage bins, 9.77% of the organics bin was contamination, 8.52% of the paper bin was contamination and around 11.15% of the recycling was contamination. An ANOVA test gave an F value of 6.6318 which was greater than the F critical value of 3.0088 meaning at least one pair of these means were statistically different. T-tests highlight these results.

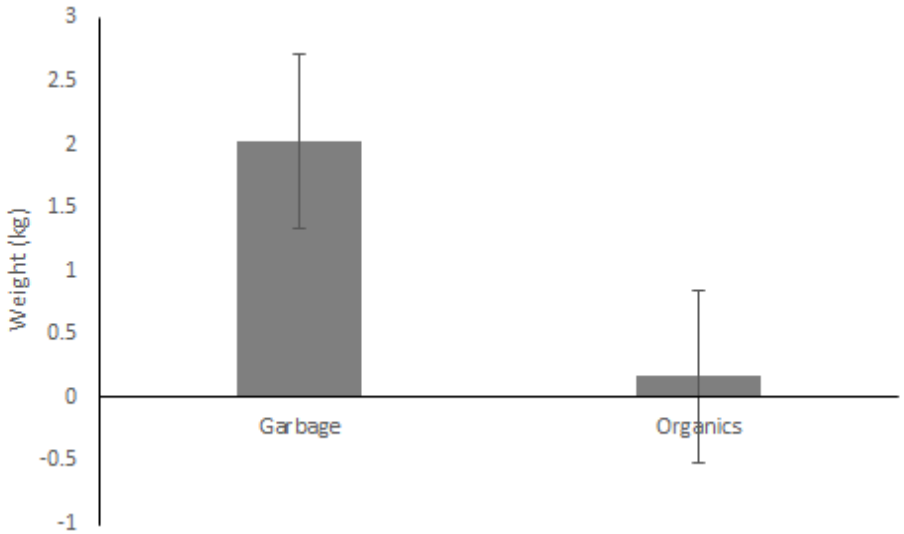

Figure 2: Comparison of t-test results between the mean contamination of the garbage and organics bin. T-test was two-sample assuming unequal variance. Results show significant difference in contamination between the two bins (p=0.034). Error bars show standard error.

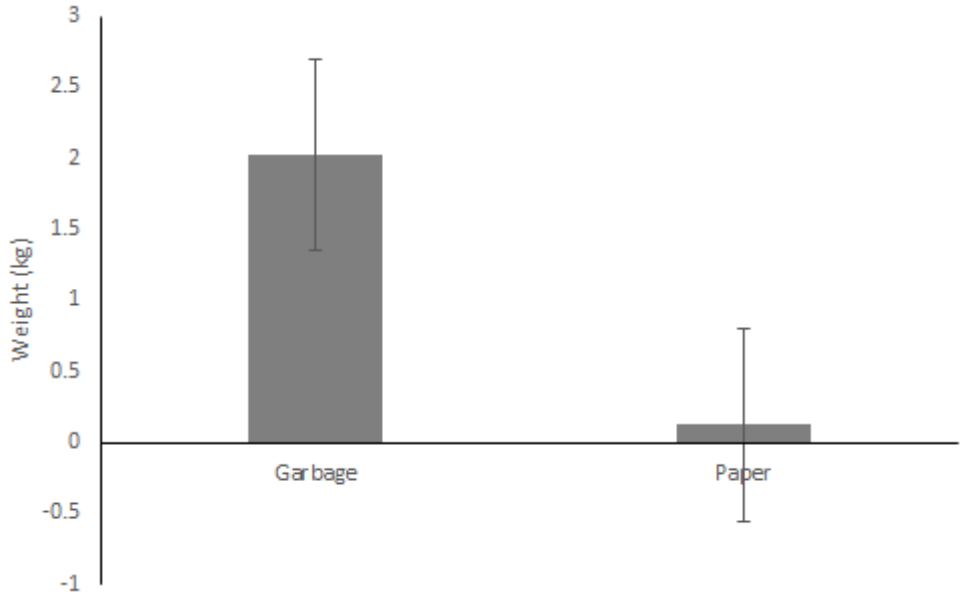

Figure 3 Comparison of t-test results between the mean contamination of the garbage and paper bin. T-test was two-sample assuming unequal variance. Results show significant difference in contamination between the two bins (p=0.031). Error bars show standard error.

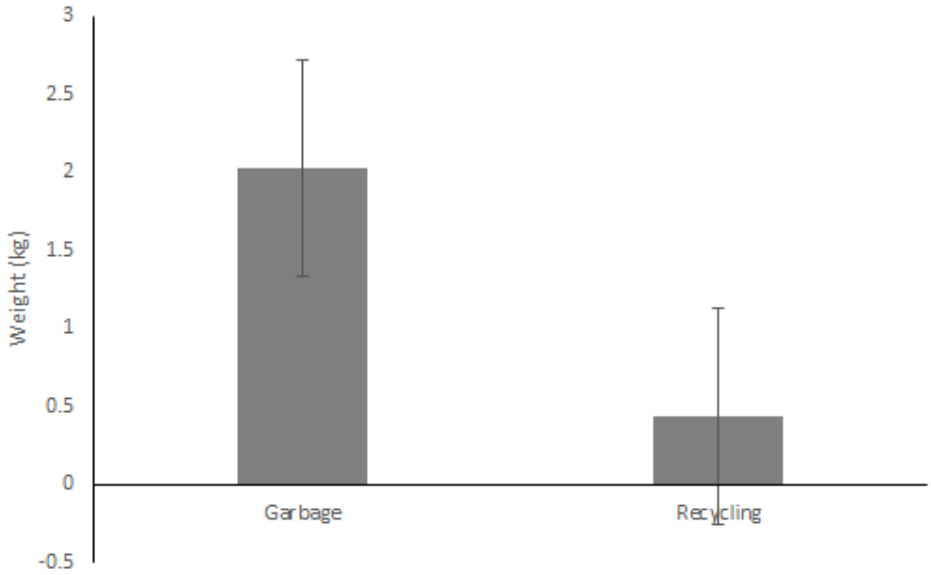

Figure 4 Comparison of t-test results between the mean contamination of the garbage and recycling bin. T-test was two-sample assuming unequal variance. Results show no significant difference in contamination between the two bins (p=0.056). Error bars show standard error.

Figures 2 and 3 show significantly more contamination in the garbage bin when compared to the contamination found in the organics or paper bins. While T-tests were conducted between the rest of the mean bin values, no other means showed a significant difference in their values ($p<0.05$).

Qualitative (Survey) results

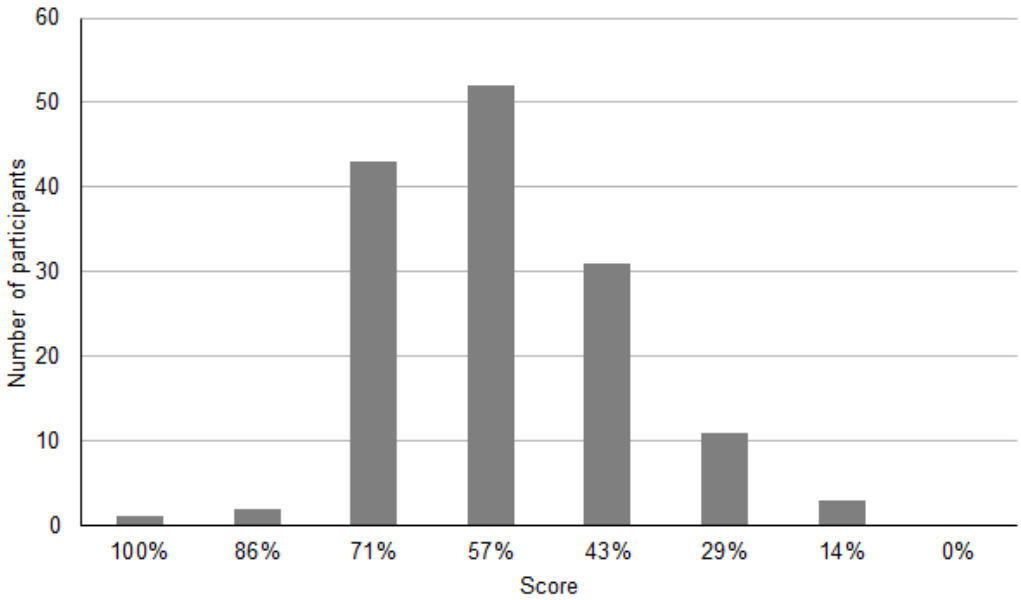

Figure 5: Knowledgeability score of participants based on results from seven sorting questions asked during the survey.

Questions can be found in appendix A. Results show a relatively bell-shaped distribution, with zero participants receiving 0% and one participant receiving 100%. 52 participants received 57%.

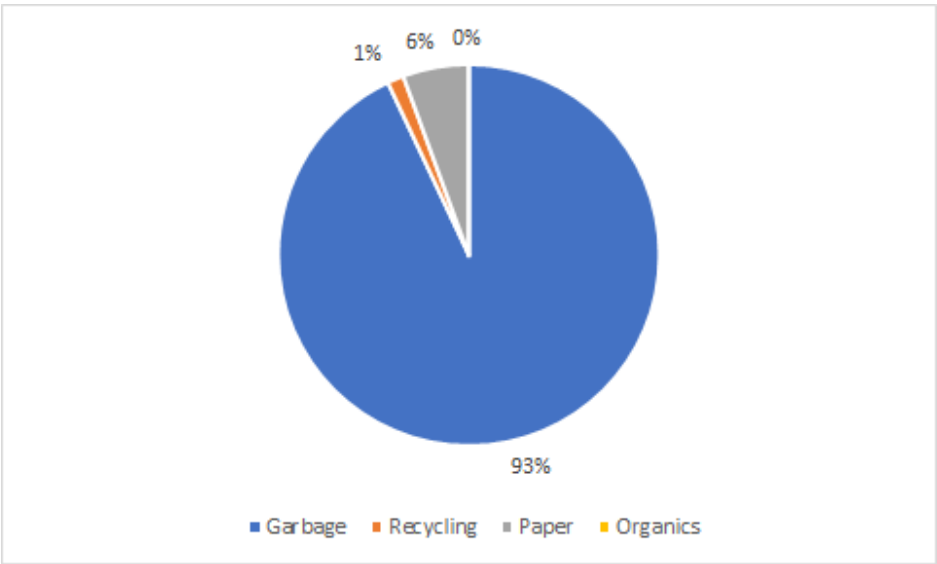

Figure 6: Survey results demonstrating where participants would sort trash if unsure which bin it belongs to based on the Halifax Municipal Waste Guidelines.

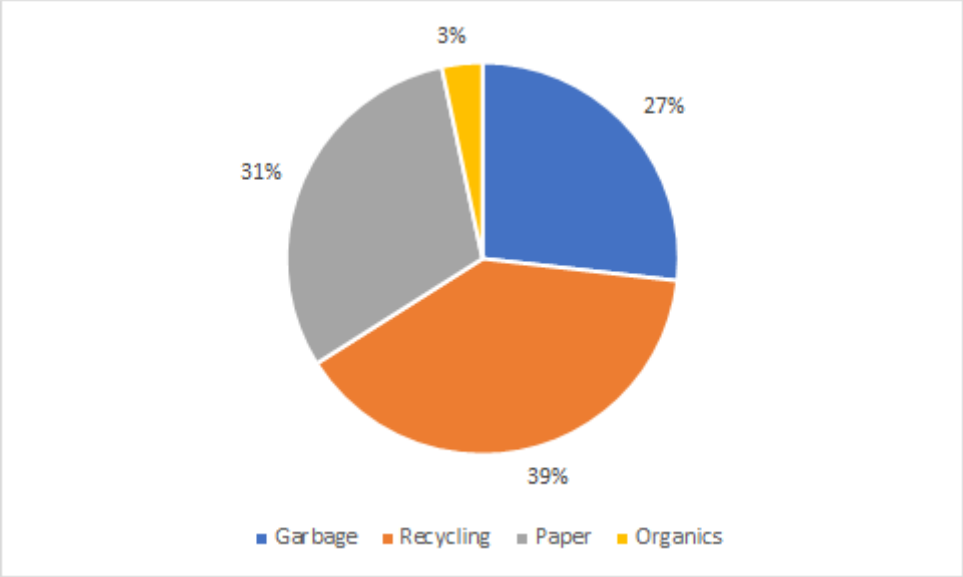

Figure 7: Number of items improperly allocated to each type of bin Based on the Halifax Municipal Waste Guidelines, representing percent contamination per bin.

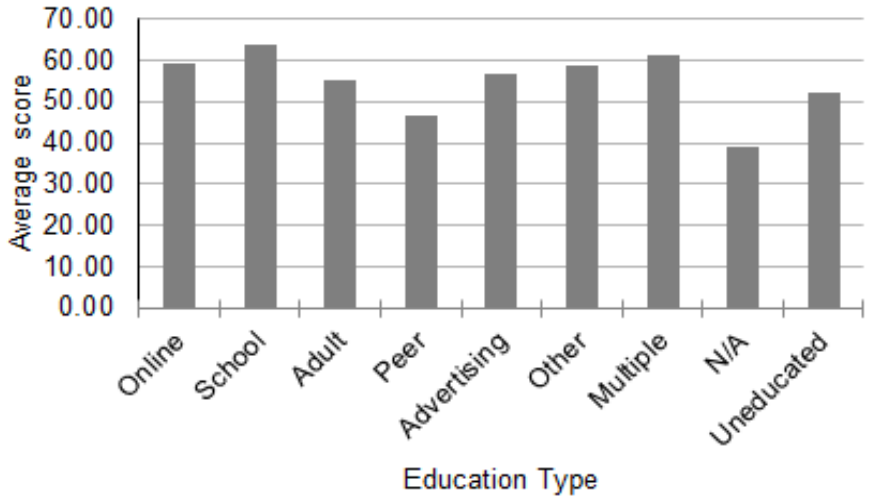

Figure 8: Average test scores on a waste sorting quiz grouped by education type for the Halifax Municipal Waste Guidelines. T-test results show the only significant difference is between the education types School and N/A with p=0.0012.

An ANOVA test showed F=3.4684 which is greater than Fcrit=2.0082. While t-tests were conducted to deduce which means were significantly different between all means, only the difference between School and N/A were significant.

5. Discussion

5.1 Purpose of Research and Our Expectations

The purpose of our research was to determine the level of waste sorting education students on Dalhousie University's Studley have based on the Halifax Municipal Waste guidelines, and if this education translated to their waste sorting habits. We predicted that students would have adequate knowledge about the waste sorting guidelines, however, that this learned knowledge would not necessarily translate to proper disposal. Based on observation, the group also expected that a large amount of the contaminants found would be common items from food vendors on campus.

5.2 Our Findings

We found that although 80% of participants claim to be at least familiar with the guidelines, around 18% of the waste collected on Studley campus is sorted incorrectly. Disproportionately, we found that garbage and recycling bins contained the most contamination. Figures 6 illustrates how participants believe they would sort their trash if unsure of which bin it belongs to, with 93% allocating it to the garbage bin, but in the same survey, Figure 7 demonstrates that the majority improperly sorted into the recycling bin. In practice on campus however, as seen in Figure 1, the garbage bin contained the most contamination, indicating most people around the campus do sort tricky items into the garbage bin. Some discrepancy could arise from the sample size we took since we did not get our target sample size of 375 for the campus, therefore, our survey results may not accurately depict how the Dalhousie population sorts waste. Further, there is potential that individuals taking the survey may feel more inclined to attempt to recycle items rather than throw everything in the landfill because they know the data will be collected. Based on the results shown in Figure 8, we believe education on the waste guidelines through school is the most

beneficial, since individuals who were taught about the Municipal Waste Guidelines through this method had the highest average score, and the only significant different score to those who were unsure on their method of education on these guidelines was (group N/A). Further studies would need to be done in the future to best ascertain which forms of waste sorting education are the most effective, as our results indicated that school was only slightly more effective than the other methods.

Students on Studley campus believe that proper waste disposal is important. When asked about this in the survey 99.3% claimed that it was important and 80% of the participants were familiar with the sorting guidelines. Nevertheless, there remains a gap between students' claimed knowledge about waste sorting and their actual knowledge. Participants were asked to sort five items into the four-bin system. These are items commonly found on campus, however, the mean test score of participants as shown in Figure 5 was 57%. This indicates that although the majority of students claim to be familiar with the waste sorting guidelines, the majority of participants could only sort approximately half of the items correctly. We could not identify exactly why this gap exists between participants' knowledge of the guidelines and their actual sorting habits. Further research could be done to examine why waste sorting education does not translate to actions. However, based on feedback from participants we believe improper sorting may be occuring on campus for a number of reasons. A large majority of participants (52%), indicated that sorting could be improved on campus if signage near the four-bin systems had more text based examples and images. Students also remarked that there should be signs that identify common items on campus that are tricky to sort to make the sorting process clearer. This corresponds to observations we noticed during our audit which was that many of the contaminants found were items commonly sold on campus from various food vendors.

5.3 Prior Research

There was a study that was conducted on the Dalhousie Campus that examined what students thought they knew about waste sorting according to Halifax Municipal Waste guidelines, compared to what they actually knew. This study found that most students claimed to have a good understanding of how waste is supposed to be sorted, and the mean test score for sorting items was 6.5/10 (Bertrand et al., 2015). These findings align with our survey results where students had an average score of 57% when asked to sort items. Bertrand et al., also identified that common campus waste items were the items that were most commonly missorted (2015), our study produced the same conclusion. Another study conducted on Dalhousie campus looked at compliance rates with the four-bin waste system. Through observation, Smith et al., concluded that 11.5% of waste disposed in the SUB was sorted incorrectly (2018). In contrast, through our study, we determined that 18% of waste on Studley campus is sorted incorrectly. Differences in these results may be due to the fact that we conducted an audit of four buildings on campus, and we chose to do an audit rather than observing students sorting their waste. We believe that an audit produces more accurate results as observation poses limitations. Our research study builds off of other studies conducted on campus about students and waste sorting. However, our study is more comprehensive as we examined level of education and knowledge of participants, and then compared it to actual amounts of waste disposed on campus.

6. Conclusion

In conclusion, we found that a sizable knowledge gap exists between what the population of Dalhousie thinks they know about properly sorting their waste and how that translates to their actual sorting habits. We also found that the majority of the populus believe that they would benefit from more posters being put up around campus, especially if they

included different examples on them so people could be exposed to different item instructions. It would also be useful for Dalhousie to start posting sorting information above bins that are area-specific, such as where common Subway and Second cup packaging should be sorted in the Killam Atrium, and posting signage about Grille Works and Zoca boxes in the LSC. This method also ties into what we found to be our most effective form of learning about waste sorting, being educated through school. As we suspect people are more likely to remember and trust information they received from school. However, further research would need to be done on this topic to determine for certain. Our group would also recommend looking into which items are specifically being thrown into incorrect waste receptacles at disproportionate rates which would allow for Dalhousie to more accurately cater its guideline advertising. Finally, if these changes were implemented, it would be interesting to see how accurate our predictions about waste sorting habits were and just how much the issue could be resolved to make Dalhousie's Studley campus a more sustainable environment.

8. Acknowledgements

As a team we would like to express our deepest gratitude for all of the people that assisted us in this research project: Dr. Amy Mui who helped us reach out to different departments of the university and provided us incredibly useful feedback on our papers and application. Our TA, Meghan Terpenning who sat and worked with us week after week helping us solve issues and providing helpful input on our research projects direction. Kareina D'Souza whom not only hosted our meeting with the Dalhousie University's facilities staff , but aided us in our data collection. The facilities team, Carla Hill, June Hoffman, Valerie Borgal, Petula Russell for organizing their workers and helping us collect our quantitative data for analysis, and the Dalhousie Student Union Sustainability Office for providing the funding for our qualitative survey prize.

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9. Appendices

Appendix A:

Waste Sorting Survey

This is a survey conducted as part of a research project for ENVS-SUST3502 Environmental Problem Solving II (Campus as a Living Lab). Your responses will be anonymous and will be made publicly available in aggregate form at the end of the term. Quotes may be pulled from the responses but will be altered to remove any identifying information. If you have any additional questions, please contact our team (envs3502waste@gmail.com) or Dr. Amy Mui (amy.mui@dal.ca)

1. Are you familiar with how to sort waste according to the Halifax Municipal waste guidelines?
   A. Yes
   B. No

2. How were you educated on these guidelines?
   _____

3. How were you educated on these guidelines?
   A. I find them clear
   B. I find them confusing sometimes
   C. I am unfamiliar with the guidelines
   D. I don't understand them at all

4. Do you separate expired food from its packaging before disposing of it?
   A. Always
   B. sometimes
   C. Rarely
   D. Never

5. Does learning about proper sorting methods make you more likely to sort waste at home?
   A. Yes, it does
   B. No, it doesn’t
   C. I do not have the infrastructure to change my sorting habits at home

6. Which bins do you use at home to sort your garbage? (Please select all that apply)
   A. Organics
   B. Garbage
   C. Paper recycling
   D. Bottle Recycling
   E. Metal/ Electronics
   F. Other

7. Do you use the four-bin sorting method available at Dalhousie?
   A. Yes, I try my best to sort at Dalhousie
   B. No, it all goes in the garbage

8. If you are unsure about which bin an item goes into where are you more likely to place it?
    A. Garbage (Landfill)
    B. Recycling
    C. Paper
    D. Organics

9. Do you believe that sorting waste is important?
    A. Yes
    B. No

10. How do you feel about the waste bin sorting options available at Dalhousie?
    A. There are enough
    B. There should be more
    C. There should be less

11. What symbol on plastic containers identifies it as being recyclable?
    A. Square
    B. Circle
    C. Triangle
    D. Diamond

12. If you threw an item into the wrong bin by accident, would you reach into it to correct your mistake?
    A. Yes I would
    B. No I would not
    C. Only if it was easy to reach

13. Is there anything that would make sorting waste at Dalhousie more clear?
    _____

14. Where would you sort the following items?*

Items	Garbage	Recycling	Organics	Paper
Paper towel				
Styrofoam				
Tin foil				
Document held together with a staple				
Plastic container (with food residue)				
Plastic wrap (cling film)				

*This question had the option to select more than one answer.

Appendix B:

HELP US SORT IT OUT

We're looking for participants to fill out a confidential waste sorting survey. As part of our ENVS 3502 class we want to assess how much individuals on campus really know about where their trash goes. You can complete this survey for a chance to

Win a $50 Visa Gift Card

You can scan the code or follow this link:
http://bit.ly/2C9gFv7

DSU Sustainability Office

Follow this link: http://bit.ly/2C9gFv7

Appendix C:

Take an online survey for a chance to win a $50 Visa gift card!
We're looking for participants to fill out a confidential waste sorting survey. As part of our ENVS 3502 class, we want to assess how much individuals on campus really know about where their trash goes. So help us sort it out!
Follow this link: http://bit.ly/2C9gFv7

Appendix D

Sample	SUB Pete's	SUB Tims	LSC	WMLC	McCain 1	McCain 2	Total
Garbage (kg)	1.6	3.15	1.65	2.9	1.45	2.25	13
Contamination (kg)	0.55	5.3	1.09	3.5	1.35	0.35	12.1
Coffee cups (counts)	10	31	51	39	24	13	168
Total (kg)	2.15	8.25	5.05	6.25	2.85	2.6	27.2
		8.45	*2.74*	*6.4*	*2.80*		

Sample	SUB Pete's	SUB Tims	LSC	WMLC	Maccain 1	Maccain 2	Total
Organics (kg)	3	1.14	0.7	2.75	0.75	0.9	9.24
Contamination (kg)	0.01	0.04	0.45	0.5	0	0	1
Coffee cups (counts)	1	1	0	0	0	0	2
Total (kg)	3.01	1.18	1.65	3.15	0.75	0.9	10.6
			1.15	*3.25*			

Sample	SUB Pete's	SUB Tims	LSC	WMLC	Maccain 1	Maccain 2	Total
Paper(kg)	0.6	0.8	1	4.55	0.85	0.25	8.05
Contamination (kg)	0.05	0.25	0.15	0.2	0.05	0.05	0.75
Coffee cups (counts)	1	5	1	0	0	1	8
Total (kg)	0.65	2	1.1	4.75	0.9	0.3	9.7
		1.05	*1.15*				

Sample	SUB Pete's	SUB Tims	LSC	WMLC	Maccain 1	Maccain 2	Total
Recyclables (kg)	0.3	2.3	7.45	8.9	0.5	1.5	21
Contamination (kg)	0.08	0.35	0.5	1.3	0.3	0.1	2.63
Coffee cups (counts)	1	9	5	6	2	0	23
Total (kg)	0.38	2.65	7.9	10.2	0.8	1.6	23.5
			7.95				